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MARKO KATILA & PÄIVIÖ RIIHINEN

MODELING NEWSPRINT CONSUMPTION A FINNISH CASE STUDY FOR THE PERIOD 1960—1986

SANOMALEHTIPAPERIN KULUTUKSEN MALLITTAMINEN: CASE-TUTKIMUS SUOMESTA AJALTA 1960—1986

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MODELING NEWSPRINT CONSUMPTION: A FINNISH CASE STUDY FOR THE PERIOD 1960—1986

Sanomalehtipaperin kulutuksen mallittaminen: case-tutkimus Suomesta ajalta 1960—1986

Marko Katila & Päiviö Riihinen

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Factors determining newsprint consumption in Finland during the period 1960—1986 were analyzed. An econometric recursive multi-equation model describing the structure of the newspaper industry was formulated and estimated to obtain information on direct factors influencing newsprint demand. Short-term and long-term demand elasticities for newspapers and newspaper advertising were estimated.

The results indicate that the main factors affecting newsprint consumption are total circulation of newspapers, volume of newspaper advertising and the change in newsprint substance weight. Total newspaper circulation was found to depend on the rate of household formation and real household income changes. Demand for newspapers was shown to be price-inelastic. Structural analysis indicates that income elasticity of newspaper demand has increased slightly over time.

The volume of newspaper advertising was shown to affect newsprint consumption via the effects on pagination. Newspaper and television advertising were found to be independent of each other, i.e., the cross price elasticity of newspaper advertising demand is not significantly different from zero. The impact of the reduction in the basis weight was found to be substantial. The estimation of long-term elasticities of demand for newspapers and newspaper advertising using dynamic models revealed that demand rigidities exist.

This case study of Finland proposes three reasons why newsprint demand has not shown clear signs of reaching a saturation level. Firstly, although population growth has stagnated in major consuming countries, the number of households has been increasing continuously. Secondly, income elasticity of newspaper demand does not show a declining trend. Thirdly, and most importantly, the main driving force behind the buoyant demand is the resurgence of demand for newspapers as an advertising medium. In forecasting newsprint consumption, in addition to projections of economic growth, attention must be paid to the rate of household formation, the development of the advertising sector, the factors affecting competition between alternative media and the resulting media-mix in advertising, and changes in the substance weight.

Tutkimuksessa tarkasteltiin sanomalehtipaperin kulutukseen vaikuttaneita tekijöitä Suomessa vuosina 1960—1986. Sanomalehtiteollisuuden rakenteen ja sanomalehtipaperin kulutukseen vaikuttavien tekijöiden analysoimiseksi spesifioitiin ja estimoitiin rekursiivinen moniyhtälömalli. Lisäksi estimoitiin sanomalehtien ja sanomalehtimainonnan kysynnän lyhyt- ja pitkäaikaiset hinta- ja tulojoustot.

Tutkimuksen mukaan keskeisimmät sanomalehtipaperin kulutukseen vaikuttavat tekijät ovat sanomalehtien kokonaislevikin ja sanomalehtimainonnan kehitys sekä sanomalehtipaperin pintapainossa tapahtuneet muutokset. Sanomalehtien levikkiin vaikuttivat kotitalouksien lukumäärä ja kotitalouksien reaalitulojen kehitys. Sanomalehtien kysynnän hintajousto todettiin joustamattomaksi ja kysynnän tulojouston havaittiin kasvaneen hieman ajan kuluessa.

Sanomalehtimainonnan volyymi vaikutti sanomalehtipaperin kulutukseen sivujen lukumäärän kautta. Sanomalehtimainonnan ja televisiomainonnan kysynnän ristihintajouston estimaatti ei merkitsevästi eronnut nollasta, joten sanomalehtimainonta näyttää olevan riippumaton televisiomainonnasta. Sanomalehtipaperin pintapainon alenemisen todettiin oleellisesti vaikuttaneen sanomalehtipaperin kulutukseen. Sanomalehtien ja sanomalehtimainonnan kysynnän pitkän aikavälin hinta- ja tulojoustojen estimointi osoitti, että sopeutuminen hinta-ja tulomuutoksiin tapahtuu viiveellä.

Sanomalehtipaperin kysyntä ei ole näyttänyt merkkejä saturaatiopisteen lähestymisestä. Tutkimuksen mukaan tämä voi johtua seuraavista tekijöistä: 1) Vaikka väkiluvun kasvu on pysähtynyt pääkuluttajamaissa, kotitalouksien lukumäärä on jatkanut kasvua. 2) Sanomalehtien kysynnän tulojousto ei näytä pienentyvän tulotason noustessa. 3) Sanomalehden keskeinen merkitys mainosmediana kokonaismainonnan kasvaessa nopeasti on lisännyt myös sanomalehtipaperin kulutusta. Ennustettaessa sanomalehtipaperin kulutusta on taloudellisen kasvun lisäksi tärkeätä kiinnittää huomiota myös kotitalouksien lukumäärän kehitykseen, kokonaismainonnassa ja eri mainosmedioiden välisessä kilpailussa tapahtuviin muutoksiin sekä sanomalehtipaperin pintapainon kehitykseen.

Keywords: demand modeling, newsprint industry, newspaper industry, recursive models, advertising, Finland.
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Contents

List of variables

A	Total newspaper advertising volume in mm^2
APP	Average number of appearance days, copies/year
AWP	Average weight of a newspaper, g/copy
B	Business cycle variable, index
CIR	Circulation of newspapers
CIRH	Circulation of newspapers per household
CQ	Consumption of newsprint by newspaper publishers, tonnes/year
GDP	Gross domestic product in marks
GDPH	Gross domestic product per household
GRAM	Substance weight of newsprint, g/m^2
HH	Total number of households
NP	Number of newspaper pages
P	Real average subscription rate of newspapers, marks/subscription
PA	Real price of newspaper advertising space, marks/mm^2
PQ	Real price of newsprint, marks/48.8 g/m^2
Q	Sales of newsprint, tonnes/year
QH	Sales of newsprint per household
TA	Real post tariff of newspapers, marks
TV	Real unit price of television advertising, marks/second
V	Average size of a newspaper in pages
W	Real wage rate in newspaper publishing, marks/hour
Y	Real household disposable income, marks
YH	Real disposable income per household

Monetary values are in 1986 prices. In estimation, all the data are in index form (base year 1960).

Preface

The study was carried out in the Department of Social Economics of Forestry, University of Helsinki. The Academy of Finland supported financially the study. Data was kindly provided by FINNPAP, Finnish Newspaper Publishers Association and Graphical Laboratory of Technical Research Centre of Finland. Markku Simula, Mikko Tervo, Ilpo Tikkanen and Seppo Vehkamäki commented on the manuscript in various stages. The final manuscript was reviewed by Risto Seppälä and Esko Uutela. Donald Smart checked the English language of the manuscript. The authors thank all the persons and organizations mentioned above who kindly contributed to the study.

Helsinki, November 1990

Marko Katila *Päiviö Riihinen*

1. Introduction and aim

11. Background

Long-term forecasts of forest products consumption at a national, regional or global level are necessary for investment planning, marketing and estimation of forest products requirements in raw materials and forest land area. Various forecasting models have been used by international organizations like FAO, market research companies, and international consulting companies with varying success. At the risk of oversimplification one can say, however, that forecasting forest products consumption was relatively easy up until the world recession in the mid-1970's. Simple functions showing the average relationship between national consumption and national income and population produced satisfactory forecasts as long as the economic environment and the factual relationships affecting forest products consumption remained stable.

During the last 10—15 years considerable research effort has been directed to the development of improved forecasting methods: models have been dynamized, new functional forms have been tried, additional explanatory variables besides income and population have been incorporated into analysis, etc. When it comes to projecting world paper consumption, the new forecasting methods have produced a wide range of forecasts and partly conflicting results. Forecasts by FAO (Demand, supply, and ... 1977, European timber trends ... 1986) and Jaakko Pöyry (1982, 1984) are higher while forecasts by e.g., Graff (1983) and Oliver (1985) are on the low side. In fact, in the latter studies paper demand is expected to stagnate or even decline.

The pessimistic projections by Graff and Oliver are based on the belief that paper products are mature products already approaching full market saturation in developed economies, and on the substitution of electronic communication media for printed media. Empirical evidence based on sound economic theory on the substitution effects, on the maximum level of global consumption, and on the reasons which cause saturation is however lacking.

In this case study on the demand for newsprint — the most important paper grade — some of the questions expressed above will be addressed, e.g., an attempt is made to account for the substitution effects *at the end-product level.* It is hoped that through a careful analysis of the factors influencing newsprint demand in Finland, useful insights for improving national consumption forecasts, in general, may be gained.

12. Objectives and method of study

The aim of this case study is to analyze factors determining newsprint consumption in Finland during the period 1960—1986. An econometric multi-equation model describing the structure of the newspaper industry will be formulated and estimated to obtain information on direct (causal) factors influencing newsprint demand. Special attention is paid to possible structural changes during the study period. Short-term and long-term demand elasticities will be estimated.

Additionally, the study aims to provide information on factors affecting demand for newspapers and newspaper advertising with special emphasis on the effects of alternative media development, i.e., on the substitution of television advertising for printed media. The study of substitution effects at the level where the actual substitution takes place is a markedly different approach to that used in earlier studies where substitution has been either completely ignored or, e.g., printing and writing papers have been assumed to be substitutes for newsprint. The inclusion of substitution possibilities in the model brings a long-term perspective to the model.

This study is analytical in nature, but it is hoped that in addition to providing information on the demand process for newsprint in general, it will generate new ideas for improving paper consumption forecasting methods especially for developed economies. Most of the world's newsprint is consumed in

developed economies; thus improved national forecasts for these countries would eventually increase the accuracy of global consumption forecasts. Practical forecasting aspects will also be dealt with in the discussion, but no attempt will be made to provide actual long-term consumption forecasts for newsprint in Finland.

13. An overview of approaches to demand modeling

Most demand studies have their origins in the Keynesian theory of the consumption function and on the theory of consumer behavior based on Engel's law. In the earlier international studies cross-sectional data were utilized in the estimation of the consumption function of the following general form:

$$(1) \quad C_i = f(Y_i, \epsilon) \quad i = 1,...,n$$

where C_i is per capita consumption of a forest product and Y_i is total or per capita income or some other measure of macroeconomic activity in country i, f is a specific functional form and ϵ is a disturbance term (Pulp and paper ... 1955, Plywood and other ... 1966, Uutela 1979). The time series form of this equation has been applied by among others Hair (1970).

Later on successive studies brought several improvements to the basic model specified by Equation 1. Alternative functional forms used include the log-normal function (World demand for ... 1960, Pulp and paper ... 1963) and a sigmoid function (e.g., Sundelin 1977). In these studies time trend was included to account for the shifts of the cross-sectional curve over time caused supposedly by substitution, long-term price movements, etc. Both Gregory (1966) and Uutela (1979) included supply factors in the model (the availability of forest resources). Further improvements were brought by studies that combined cross-sectional and time-series data, and dynamized the static basic model by introducing lagged consumption and income variables (European timber trends ... 1976, Buongiorno 1977). Singh and Nautiyal (1986) analyzed paper and paperboard consumption using alternative formulations of stock adjustment models, and an adaptive expectation model.

A common feature of all these studies is the exclusion of price variables from the models. Rapid increases in the real prices of paper and board in the mid-1970's necessitated the analysis of price-induced substitution. Models including both product and substitute prices have been used to examine forest products consumption both at a global and national level. The time-series form of this approach

$$(2) \quad C(t) = f(Y(t), P(t), P_s(t), \epsilon(t)),$$

where Y is income, P is product price, P_s is the price of the closest substitute and ϵ is the error term, has been used, e.g., by McKillop (1967), Adams and Blackwell (1973), Adams (1977) and Baudin (1977) in national or regional studies.

International studies have utilized pooled time-series cross-section data and have improved upon the previous model by using country specific dummies and dynamizing the model (Buongiorno 1978, Baudin and Lundberg 1984, Suhonen 1984), by including literacy rate as an explanatory variable (Demand, supply, and ... 1977), and by using time-trend to represent the effects of determinants of paper demand other than economic activity and prices, e.g., substitution of electronic media for printed media (Wibe 1984, Baudin and Lundberg 1985, 1987, European timber trends ... 1986).

These latter studies are among the most advanced practically oriented studies on forest products demand: they are dynamic, try to analyze price induced substitution and allow for differences between countries and levels of economic development. They do not, however, give any explanation of the factors which may lie behind the dummy variables (country differences remain unexplained), the substitution process is not analyzed in a realistic way, and product groups are often too heterogenous.

Other approaches applied recently include market models (e.g., Adams and Haynes 1980, IIASA Forest Sector Project, see Dykstra and Kallio 1987), use-factor approach (An analysis ... 1980, Veltkamp et al. 1983, European timber trends ... 1986), derived demand approach based on production or cost functions (Doran and Williams 1982, Rockel and Buongiorno 1982) and the use of growth curves (Graff 1983). The use of growth curves can be criticized for being mechanical, uninformative, and lacking theoretical validity. Market models have not really paid as much attention to demand modeling as to modeling international/interregional trade, so this approach is not very useful as far as the study objectives are concerned.

Use-factor, and production or cost function approaches have properties that make them suitable for a more detailed demand analysis. They are based on the concept of derived demand, they try to study substitution at the level where the actual substitution process takes place, and they pay attention to the structure and behavior in the end-use sectors. In addition, use-factor models try to separate the consumption process into components that are sensitive to changes in the price of a forest product, and into components that are not.

In this study, it was decided to develop further the approach presented by Riihinen (1962) in his study on newsprint sales in Finland, and that was later on applied by Simula (1971) in his study on the sales of printing and writing paper. This approach has conceptually some similarities with the use-factor and derived demand approaches based on production or cost functions, but it can, however, be considered a totally different approach suitable for a detailed consumption analysis at a country level.

Riihinen's (1962) time-series study is based on the concept that demand for newsprint cannot be studied in isolation from the newspaper industry. A structural model was built to describe the decision-making process and the timing of decisions in purchasing newsprint for newspaper production. When alternative models were compared it was found that the models based on the economy of the newspapers' customers, i.e., readers and advertisers, performed the best in explaining variations in the sales of newsprint.

In addition to Riihinen's 1962 study, there has not been much relevant work on the economic aspects of the Finnish newspaper industry with the exception of the studies carried out by Mähönen (1975) in the Economic Department at the Board of Posts and Telecommunication. He modeled the formation of subscription prices and analyzed factors affecting newspaper demand in different newspaper categories with the ultimate aim of trying to forecast the number of newspapers to be distributed by mail.

2. Supply of and demand for newsprint

Newsprint is a relatively homogenous paper product that has practically no substitutes. Newsprint is used almost entirely for the production of daily newspapers, but it is also used increasingly for the production of free delivery newspapers (sheets) and for direct advertising. On the other hand, other paper grades are being used for making newspapers. Though newsprint can be viewed as a homogenous product, substitution possibilities between different "types" of newsprint or paper do exist, and there have also been changes in the product characteristics over time as a result of developments in paper technology.

The main product characteristics of newsprint are substance weight (g/m^2), runnability, printability (brightness, opacity, smoothness) and surface strength. Most of the paper used is standard newsprint, but different subgrades or newsprint specialties that differ, e.g., with respect to the above mentioned properties have been developed in the late 1970's and in the 1980's as a response to changes in specific end-uses, and in production technology (e.g., increased use of offset printing). The furnish composition of newsprint has been gradually changed from groundwood and sulfite to today's combinations of thermomechanical, chemithermomechanical, recycled fibre and sulfate pulp.

The most noticeable change in the product characteristic of newsprint affecting the demand for newsprint has been reduced substance weight. Between 1960 and 1988 the average substance weight decreased from about 52 g/m^2 to less than 45 g/m^2. Most of this decrease took place after 1973 mainly as a result of newsprint producers' desire to save fibre and energy, and the newspaper industry's desire to reduce delivery and production (newsprint) costs. Reduction in

substance weight means simply that more printing surface is produced from the same amount of raw material (in tonnes).

Most of the newsprint consumed in Finland is produced in Finland; imports of newsprint are negligible. On the other hand, only a small part of the newsprint produced in Finland is sold in the country; exports have accounted for about 90 percent of the total newsprint production (Finnpap Statistics). The number of newsprint plants in Finland is relatively small, and it has decreased over time because optimum machine size has increased from about 80 000 tonnes in the 1960's to over 200 000 tonnes at present.

Newsprint is mainly marketed through a joint sales organization — the Finnish Paper Mill's Association (Finnpap) that acts like a market-sharing cartel. The price of newsprint is negotiated annually between Finnpap and the Finnish Newspaper Publishers Association, and the price is fixed for the following year after the negotiations. The industry's short run supply curve is horizontal — producers are willing to sell all the newsprint publishers need at the agreed price. Individual paper mills can, however, use product differentiation as a means of competition. The domestic price level is adjusted on the basis of the world market prices; if newsprint producers try to charge too high a price, buyers at least in theory have the option of buying newsprint from abroad.

The consumption of forest products in competitive markets is determined simultaneously by forces of supply and demand. In the case of newsprint, the worth of simple supply-demand models with simultaneous price and quantity adjustment is, however, questionable for several reasons. Firstly, demand for newsprint is derived demand. Secondly, newsprint markets are not competitive in the classical economic sense (the market type is closer to a bilateral monopoly). And thirdly, short-term price elasticity of demand for newsprint is low because of its small share in total production and delivery costs (Suhonen 1984, Duerr 1988).

All these factors point towards the conclusion that in order to examine the newsprint demand process it is necessary to consider factors that ultimately determine newsprint demand in the *end-use market*. Therefore, a detailed study on newsprint demand/consumption should focus on the economy of the newspaper industry, and on the factors that affect newspaper demand.

3. Economy and decision-making in the newspaper industry

31. Market and product characteristics of newspapers

Several definitions of a newspaper exist in alternative statistical yearbooks, organization publications, etc. In this study the definition by the Finnish Newspaper Publishers Association is used: "A newspaper is a publication following and commenting on daily news, available for sell to everyone and that appears regularly at least three times a week" (Facts about Finnish... 1985).

At present there are 101 newspapers with a total circulation about 3.2 million in Finland, over a million more than in 1960. Annually close to one billion copies of newspapers are published that consume thousands of tonnes of newsprint (in 1989 about 200 000 tonnes). It must be noted that this definition of a newspaper excludes local papers or any paper that appears less than three times a week (over 170 in 1987) or that are delivered free of cost (about 150 in 1987), and these publications also consume newsprint in increasing amounts. For example, the annual volume of free delivery newspapers has increased from 35 million to about 200 million copies since 1973 (Joukkoviestintätilasto 1987).

The development of the number and volume of newspapers, and local and free delivery newspapers is shown in Appendix 1. Even if the number of newspapers has stayed relatively constant between 1960 and 1980, there have been significant increases in circulation, annual volume of newspapers and in the total number of pages. The relative growth has been fastest for the total number of pages.

The main function of a newspaper is to inform: to provide news, advertisements (display) and classifieds for the readers. The secondary functions are to educate and entertain. Newspaper publishers may see newspapers as having an additional function, that is, to guide public opinion. The relative importance of the functions depends on the type of newspaper (e.g., morning vs. evening paper).

Function	Competing Media
Major:	
Inform	
- news	TV, radio
- advertising (display)	
* local	cable TV, local commercial radio stations, free sheets
* national	TV (MTV)
- classifieds	
* local	cable TV (videotex), local commercial radio stations, free sheets
* national	none
Minor:	
Entertain	TV, radio, videos, computers
Educate	magazines, books, TV, radio

Figure 1. Functions of newspapers and competing media.

In a classification based on competitive position newspapers can be divided into largest leading papers, other newspapers published in the Helsinki metropolitan area, leading newspapers in the economic regions, leading regional papers and papers in Swedish, other singular newspapers in their areas of publication, second newspapers in their areas of publication, and evening newspapers (Parlamentaarinen lehdistökomitea 1986).

The major newspapers have the power to "set the rules" for competition, e.g., second newspapers in their area of publication are often forced to sell advertising space at considerably reduced rates in order to compete with them. Since the 1960's the four largest newspapers (Helsingin Sanomat, Aamulehti, Turun Sanomat, Iltasanomat) have accounted for 25 to 30 percent of the total circulation, and their consumption of total newsprint use has been even higher, about 50 percent. The largest newspaper, the Helsingin Sanomat, has accounted for 12—14 percent of total newspaper circulation.

Newspapers do not only compete with each other in performing the above mentioned functions, but they have to compete for consumers' time with other media that provide similar services/products (television, videotext, teletext, radio, magazines and books) and other leisure activities. This competition has become more intense during the last fifteen years together with increased leisure time and income levels, the start of color television broadcasting, cheaper electronic media equipment, the penetration of videos and cable television, and the emergence of commercial local radio stations in 1985.

It is, however, debatable whether electronic media and newspapers can be automatically regarded as (complete) substitutes as is customarily done. They compete in some areas, e.g., local newspapers and radio stations compete for the same advertisers but on the other hand in some areas they complement each other, or are not related at all. In Fig. 1 the main functions of newspapers are listed together with competing media performing the same functions.

People buy newspapers mainly because they want to have information. In this respect the newspaper is a very powerful medium because people want to have the news flexibly and fast, preferably early in the morning before going to work. Most of the newspapers in Finland (in 1986, 99 out of 101) are morning papers, whose "freshness" is guaranteed by a very effective morning distribution system. Nationally, television does not compete with newspapers in the morning, and in addition, one can read the

news flexibly at any time of the day. Several surveys in Finland have shown that newspapers are the main source of (local) news, advertisements and classifieds for most of the people. People also consider newspaper advertising to be more reliable than television advertising (Suuri Sanomalehtitutkimus 1988).

Finns are very accustomed to reading newspapers, and it has been proposed that they consider newspaper almost a necessity (Riihinen 1962, p. 18). Customarily 92—98 percent of the population (over fifteen) read newspapers daily, in addition to which 20 percent of the households buy an evening newspaper at least once a week. During the 1980's, the coverage of TV and radio was about 80 % and 70 %, respectively. If compared internationally, the circulation per 1 000 inhabitants is among the highest in the world, and the number of newspapers per household is and has been at the very high level of 1.4—1.7 newspapers per household (Facts about Finnish... 1985; Suuri Sanomalehtitutkimus 1988). If newspapers really have the characteristics of a necessity, the substitution of electronic media for newspapers may be much more difficult than is commonly thought. If such substitution does take place it would probably be much slower than is presently envisaged.

Newspaper and television advertising cannot, a priori, be claimed to be complete substitutes mainly for three reasons. Firstly, the target groups of advertisers differ considerably: newspaper advertisements are mostly locally targeted, while television advertising is mainly national. Secondly, advertising sectors differ: e.g., trade advertising is mainly directed to newspapers and brand advertising to television (Advertising Expenditure in Finland 1988). Thirdly, product groups that are usually advertised in a short notice can not be placed on TV because of the time needed to produce the commercial and getting the TV spot. Also, when a certain brand is advertised nationally on television, one still needs the information about the exact price and places where it can be purchased (spatial aspect).

Newspapers and free delivery newspapers are the main sources for *local* advertising and classifieds; in fact, before the emergence of local commercial radio stations and cable television in the mid-1980's they were the sole source for this type of information. However, commercial local radio stations have increased their advertising revenues very quickly (by 83 percent in 1988 according to Advertising Expenditure in Finland 1988), and they may affect the economy of newspapers in the the future. As commercial radio stations have not been operational for a long time their impact cannot be analyzed in this study.

It follows from the above discussion that a complementary relationship between national radio and television advertising, and newspaper advertising is, a priori, as probable as a competitive relationship; this is also demonstrated by the increased use of advertising campaigns, where newspaper advertising is complemented by television and/or direct advertising. It can also be hypothesized that television and radio may be simultaneously both complementary and partial substitutes to newspaper advertising, or that they are not related at all, depending on the product/target group. Empirical knowledge on this question is however lacking.

This subchapter has described the structure of the Finnish newspaper industry, its relation to competing media and the product characteristics of a newspaper. At the same time it forms the basis for modeling the demand for newspapers. The demand for newspapers can be derived from the household demand for information, and to a lesser extent for entertainment and education. The demand for newspapers can be hypothesized to be (relatively) price inelastic because of the nature of the product (necessity, no close substitutes), and because newspapers represent only a small fraction of total household expenditures (e.g., Riihinen 1962, Suhonen 1984, Duerr 1988, p. 13—5, 13—6). Expenditures on newspapers have accounted for less than one percent of total household expenditures. Another component of newspaper demand is the demand for advertising space by firms, individuals, etc. These two demand components will be discussed in more detail in the next chapter on the sources of newspaper publishers' revenues.

32. Sources of revenue

321. Advertising income

Newspapers in Finland have three sources of income: advertising sales, subscription sales including sales of single copies, and government subsidies. The relative proportions of these sources vary between different types of newspapers. Subsidies have accounted only for 1.8—4.4 percent of the turnover of the newspaper industry since subsidization was started in 1971, so they can be ignored in this study even if their importance for the economies of second and political newspapers can be quite substantial (Suomen lehdistön... 1987, p. 5—6).

The economy of newspapers is based on advertising income. On average nearly three quarters of their income come from advertising sales with an exception of free delivery newspapers that get all their income from advertising, and evening papers that get most of their income from the sales of single copies (Facts about Finnish... 1985). The income share of advertising has remained approximately at this level since the early 1970's with the exception of fluctuations caused by business cycles).

The relative shares of advertisements and editorial material in a newspaper are, however, not significantly affected by these fluctuations because newspapers have unofficial "rules" concerning the amount of advertisements relative to editorial text. This implies that the pagination of newspapers is primarily affected by changes in the volume of advertising and not by the actual number of newsworthy events except for special occasions such as the Olympic Games or elections. On average, one third of newspapers' contents consists of advertisements (display) and classifieds (Facts about Finnish... 1985).

The level of advertising income of an individual paper depends to a very great extent on its *coverage* in the distribution area, and in the case of a national newspaper, on national circulation. Increased circulation affects advertising income in two ways. Firstly, newspapers can increase advertising rates because advertisements reach more people. Secondly, increased coverage, i.e., higher circulation attracts more advertisers and thus increases advertising volume.

Advertisers base the intermedia choice, i.e., the choice between alternative media, and the intramedia choice, i.e., the choice between representatives of a same medium largely on the circulation/viewer figures. Or to be more specific, on the coverage by target (reader, viewer) groups and on the contact price that is the cost of advertising divided by the total number of contacts by a target group.

Competition between newspapers, TV, radio, etc. does not really deal as much with competition for readers, viewers, or listeners as with competition for advertising revenue. Newspapers do not only compete with alternative media but they compete with each other. Once a newspaper falls into second place in its distribution area it becomes a loser in the eyes of the advertising agencies and retail stores, and it starts losing advertising income.

There has been a steady increase in total advertising expenditures and volume. In 1960 the share of total advertising expenditures of GDP was 0.81 percent, in 1986 total advertising expenditures amounted to about 5 943 million marks that represented 1.66 percent of the gross domestic product (GDP). During the same period newspapers including local and free delivery newspapers increased their market share of total advertising expenditures from 38.3 percent (32.7 in 1970) to about 60 percent while the share of television (and radio) advertising decreased from 9.4 in 1970 to 8.2 percent in 1985 (Joukkoviestintätilasto 1987).

During the 1980's advertising expenditures have on average increased twice as fast as the GDP which has stimulated newspaper advertisement sales: the relative market share has grown only slightly but the annual real growth has been about 10 percent. Over the past few years the relative growth of advertising expenditures has been fastest for free delivery newspapers. Fig. 2 shows the real advertising expenditure by media in 1980—1987.

During the study period the average price of advertising space has been influenced not only by steadily increasing circulation figures but also by the introduction of four-color advertisements made possible by the development of offset printing technology. Since the mid-1970's the share of color advertisements of total advertising column meters has increased from a few percent to about one third, and this has increased the average

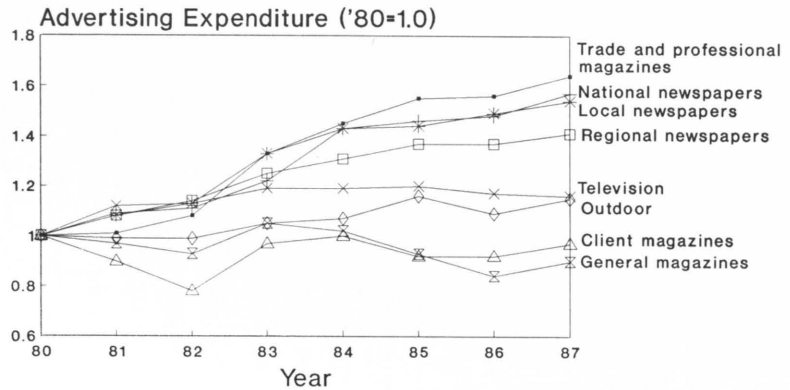

Figure 2. Advertising expenditure by media, 1980—87. Source: Advertising expenditure in Finland 1987.

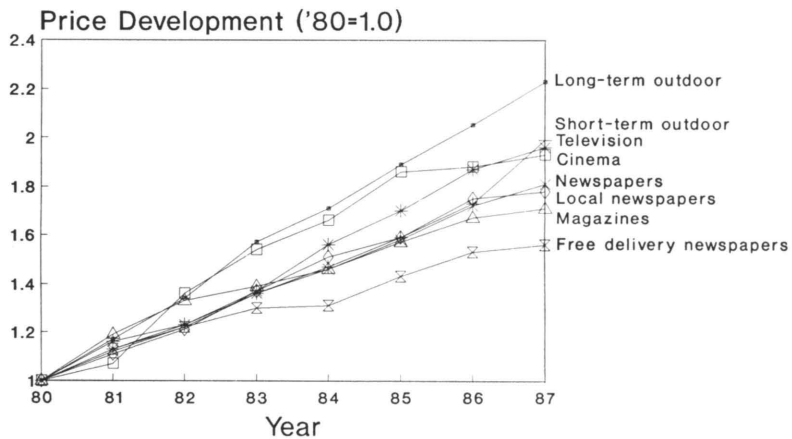

Figure 3. Price development of alternative media. Source: Advertising expenditure in Finland 1987.

price of advertisements. Full-color advertisements cost 40—65 percent more per 1 000 mm than black and white advertisements (Facts about Finnish... 1985, Taskumedia 1988).

The relative price development of alternative media is shown in Figure 3. The publisher can try to adapt his economy to changes in the newspaper production and delivery costs by increasing advertisement rates, but the possibilities to do that are limited by the competitive position of the newspaper with respect to other newspapers and electronic media because demand for newspaper advertising is likely to be elastic.

322. Subscriptions

Newspapers' derive an average of one quarter of their income from subscription sales because of their large proportion of fixed subscribers. Sales of single copies bring less than one percent of newspapers' income with an exception of two evening newspapers that get most of their income from street sales (Suomen lehdistön teknologia... 1987, p. 4).

Since the early 1970's subscription sales have developed at the same rate as advertising income. Growth in subscription income has been based on increases in circulation and real subscription rates. Total newspaper circulation in Finland has grown annually at a rate of 2.5 percent since 1970. In 1960—1970 the growth rate was about one percentage point smaller.

Real subscription rates stayed almost constant into the mid-1970's; as a result of the oil crisis newsprint prices went up, and increased production costs were transferred to subscription prices. Since 1960 real subscription rates increased annually at an average rate of two percent compared to three percent growth in real newspaper advertising rates. Newspaper publishers can try to compensate for increased production costs by transferring at least part of increased costs to subscription rates, because they know that demand for a newspaper is quite inelastic: subscribers are not likely give up a newspaper because of a small increase in its price. Subscribers to more than one newspaper may however well consider abandoning one of them if prices rise.

33. Cost structure

The main cost components in newspaper production are technical production, editing, administration and marketing, and distribution. Since the early 1970's the share of distribution costs has increased fastest while technical production costs have declined. In 1985 technical production and editing had the largest cost shares, 36.5 and 28.3 percent, respectively.

The relative cost shares vary according to the size of the paper and distribution area. Newsprint costs amount to about 20 percent of turnover on average, but in small newspapers newsprint costs may be less than ten and in large newspapers more than 20 percent of the turnover. The cost of newsprint relative to total newspaper manufacturing costs has been quite stable because of the slow development of real newsprint price and reduced substance weight. As a whole, changes in the relative cost shares would have been much greater without the introduction of new technology and changes in the organization of distribution.

Production of newspapers has changed a lot during the last decade as a result of huge investments in modern technology at all stages of production. Offset became the main printing method in newspaper publishing during the 1970's: in 1984 the spread of the offset process measured as a percentage of total paper consumption was complete.

The spread of the offset process has improved the competitiveness of newspapers as an advertising medium because of the possibility of using high-quality four-color prints. Almost all papers now have facilities to print color pictures and full-color advertisements (Facts about Finnish... 1985). The increased use of color has made publishers demand higher quality newsprint. The change from letterpress to phototypesetting has, in turn, favored a reduction in substance weight (Rennel 1984, p. 83).

In spite of the modernization process the newspaper industry is still very labor intensive. Techniques for computerization of text and image manipulation has eliminated a great deal of the manual work in editorial offices, advertising departments and in composing rooms, whereas rationalization of distribution has been much more difficult to accomplish. For example, at present the largest newspaper in Finland, the Helsingin Sanomat, employs 4700 people, of which 2100 work in distribution, most of them part-time (Helsingin Sanomien kuukausiliite 28.5. 1989).

Total distribution costs in real terms have increased annually by about 4 percent since 1978, but newspapers that take care of distribution themselves have been able to reduce the real costs of distribution (Suomen lehdistön teknologia... 1987, p. 7). The newspaper industry has responded to increased distribution costs by demanding newsprint of lower substance weight to minimize transport costs for newspapers with wide distribution areas. Lower substance weight is also desired to reduce the number of paper rolls handled in the warehouses and the number of roll changes in the printing presses (Rennel 1987).

34. The decision-making process for purchasing newsprint

The above three subchapters served the dual purpose of giving a broad picture of the economy of the newspaper industry and its environment, and generating plausible hypotheses for modeling the demand for newsprint and newspapers. This discussion shows that the demand for newsprint cannot

be described and analyzed adequately in isolation from the newspaper market. It is also apparent that the demand process for newsprint consists of some components which depend on the price of newsprint and some which do not. In the following the components determining the demand for newsprint are presented in a general form. These models can be understood as hypotheses that are to be tested in the empirical part of the study. The detailed models in their estimated form with time lags, etc., are presented in the next chapter.

The following presentation of the decision-making process of the newspaper industry is a simplification: the industry comprises about hundred newspapers, so treating them as a whole obscures a lot of variation in the decision-making process. The same applies to the subscribers and advertisers. Also, the system of models includes only the major factors considered important in the analysis, or that fit the theoretical framework.

The starting point of the study is the simple relationship (identity) that the amount of newsprint (Q) required annually by the newspapers equals the annual total number of pages (NP) multiplied by the weight of a newspaper page (AWP):

(3) $Q = NP*AWP.$

The development of average weight is directly correlated with the changes (reduction) in substance weight. In the model, substance weight variable is considered exogenous, as a kind of correction factor although it could be presented as a function of increases in distribution and newsprint (fibre) costs.

The development of the total number of pages, NP, depends on total circulation (CIR), average number of appearance days (APP), and average size (in pages) of a newspaper (V):

(4) $NP = CIR*APP*V.$

APP is considered to be a constant even if in some years the newspaper press's annual volume (CIR*APP) has increased faster than that figure because many newspapers have started appearing more frequently than earlier.

The consumption of newspapers, i.e., changes in circulation (CIR) can be derived from the household demand for information. Household demand depends on the size of the population and especially on its structure, i.e., on the number of households (HH), the purchasing power of households (Y), literacy rate, reading habits, and the average subscription price of newspapers (P). Literacy rate and newspaper reading habits have been practically constant for several decades, so they do not play any role in the modeling process. Therefore, total circulation can be written

(5) $CIR = f(HH, Y, P).$

The average subscription price depends on the production and distribution cost development: newspaper publishers attempt to compensate for increased production costs by offsetting at least part of increased costs by increasing subscription rates. Because of the small contribution of subscription income to the total income of a newspaper, publishers are likely to base subscription rate decisions on the possible effects on total circulation, and consequently on advertising income. This implies an assumption that publishers try not to maximize subscription income but total net revenues. This hypothesis will be tested, but in the basic model subscription price is determined by newsprint (PQ), labor (W), and distribution (TA) costs:

(6) $P = f(PQ, W, TA).$

The average size of a newspaper, V, can be hypothesized to be a function only of the volume of advertising (A) because of the relatively fixed relationship between the share of editorial text and advertisements in the total available space.

(7) $V = f(A).$

The volume of advertising, i.e., the demand for advertising space by firms, individuals etc., can be expressed, in turn, as a function of the level of general economic activity (GDP) and on the price of advertising space (PA) relative to the price of television advertising (TV).

(8) $A = f(GDP, PA, TV).$

The price of advertising space, in turn, depends mainly on circulation, and to some extent on the production costs.

(9) $PA = f(CIR, TA, PQ, W).$

To summarize and give a clearer picture of the factors affecting newsprint consumption, the structure of the model in a simplified form is shown schematically in Fig. 4 where arrows indicate the assumed direction of the influences.

The knowledge of the timing of the decision making, i.e., the time lags by which the decisions by publishers, subscribers and advertisers follow each other is important in formulating the functions to be estimated. Most newspaper subscriptions are annual; subscription is usually paid at the end of a year or at the beginning of the next year. However, during the last decade the timing of the subscription decision has become more varied because of continuous subscriptions. Total circulation is then affected by changes in purchasing power and the number of the households with a lag of one year, because subscribers make their decisions for the year t in the light of their (disposable) income during the year t-1. Sales of single copies, however, are affected by the income level in the same year. Because of the large proportion of subscription sales, subscription rates have to be decided before other considerations, and the increased production costs, e.g., increased newsprint price or delivery costs cannot be taken into account until the following year.

The volume of advertising in a certain year is associated with the level of economic activity in the same year with the exception of classifieds, e.g., death notices that are independent of business cycles. The rates for advertising space in a certain year are influenced by the circulation figures in the preceding year, because of the lag in obtaining official circulation figures for any given year.

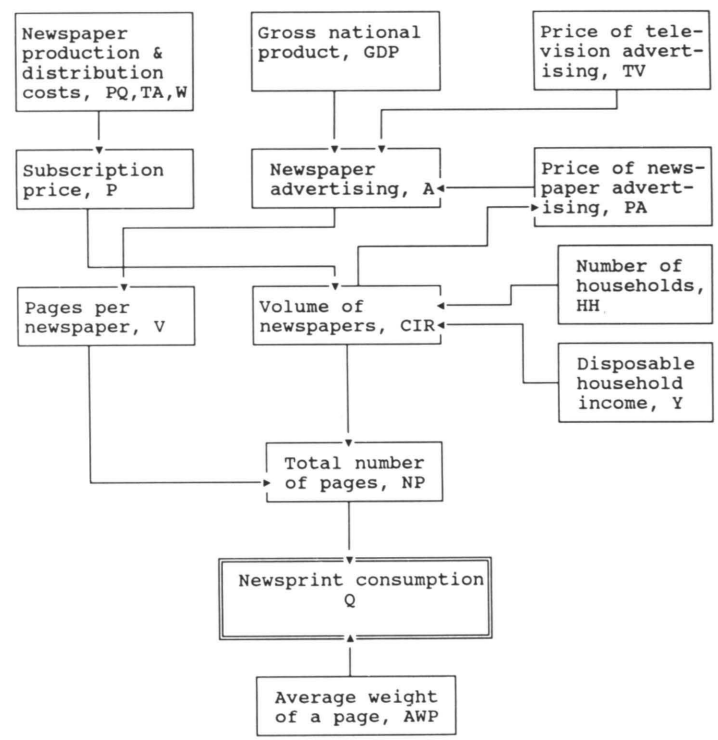

Figure 4. The model structure for newsprint consumption.

4. Models, estimation, and data

41. Models

The system of equations forms a recursive multiequation model, i.e., each of the endogenous variables can be determined sequentially; there are no simultaneous influences between any pair of variables. Before the individual models can be estimated, the form of the function describing the statistical relationship between variables must be selected. Because of the large number of equations it was considered necessary to try keep the model as simple as possible. The functional form selected was a linear logarithmic function

$$(10) \quad \log y = \log \alpha_1 + \alpha_2 \log x_1 + ... + \alpha_n \log x_{n-1} + u$$

that implies a multiplicative relationship between variables and the error term. The logarithmic form can be justified here because we are more interested in relative changes, possible heteroscedasticity is reduced, and because elasticities, e.g., income and price elasticities of demand can be noted directly from the coefficients of the estimated models. All the variables are in the index form (1960 = 1). In cases where a log-linear function cannot be fully justified alternative nonlinear functional forms were tried.

The basic equations without the error terms are presented here in the same order as they are estimated (all monetary variables are in real terms):

$$(11) \log P_t = \alpha_0 + \alpha_1 \log PQ_{t-1} + \alpha_2 \log TA_{t-1} + \alpha_3 \log W_{t-1}$$

where P is the newspaper subscription price, PQ is the price of newsprint, TA is post tariff rate for newspapers, W is the wage rate, and t-1 stands for a lag of one year.

$$(12a) \log CIR_t = \beta_0 + \beta_1 \log Y_{t-1} + \beta_2 \log P_t + \beta_3 \log HH_{t-1},$$

where CIR represents total circulation, Y is disposable household income and HH is the number of households.

$$(13) \quad \log PA_t = \mu_0 + \mu_1 \log CIR_{t-1},$$

where PA is the price for newspaper advertising space. Because this is a simplified model, experiments will also be undertaken to study the influence of production and distribution costs on advertising prices.

$$(14) \quad \log A_t = \tau_0 + \tau_1 \log GDP_t + \tau_2 \log PA_t + \tau_3 \log TV_t$$

where A is the newspaper advertising volume, GDP is the gross domestic product and TV is the unit price of television advertising. Parameters τ_1, τ_2 and τ_3 represent short-term income, own-price and cross-price elasticities of demand for newspaper advertising, respectively.

$$(15) \quad \log V_t = \Theta_0 + \Theta_1 \log A_t,$$

where V is the average size (in pages) of a newspaper.

The amount of newsprint required by newspapers (Q) is then derived using the equation

$$(16) \quad Q = NP*AWP = CIR*V*APP*AWP,$$

where NP is the total number of pages, AWP is the average weight of a newspaper page (newsprint substance weight is used here as a proxy). The average number of appearance days (APP) is excluded from this equation because it is assumed to stay constant over time.

It is common in time-series studies for a high degree of determination to be obtained because of the common trend in all variables which may make the interpretation of individual parameters difficult. To study the possible trend effect the equations are also estimated in a first order logarithmic difference form, and the parameters of the basic and difference models are compared.

One of the objectives of this study is to analyze whether structural changes in the economy of the Finnish newspaper industry having an impact on the newsprint demand may have taken place. Most of the interest here is directed towards studying possible changes in own-price, cross-price, and income elasticities of demand for newspapers and advertising. Because of the large number of equations and the recursive nature of the model, it was decided to study the possible structural changes by simply estimating the models for two subperiods, in spite of the relatively small number of degrees of freedom. Because it is known that the oil crisis had a decisive impact on newsprint price and on the economy of newspapers in general, the year 1975 was chosen as a dividing point for the two subperiods (1960—1974, 1975—1986). Model 14, and Model 12a on per household basis

$$(12b) \quad \log CIRH_t = \beta_0 + \beta_1 \log YH_{t-1} + \beta_2 \log P_t,$$

where circulation per household (CIRH) is a function of disposable income per household (YH) and the subscription price, both belong to the most important type of functions applied in general demand studies. Parameters β_1 and β_2 are income and own-price elasticities of demand for newspaper subscriptions, respectively. These models can be dynamized to study both the long-term and short-term elasticities of demand (see Buongiorno 1978, Suhonen 1984):

$$(17) \quad \log CIRH_t = \beta_0 + \pi \log CIRH_{t-1} + \beta_1 \log YH_{t-1} + \beta_2 \log P_t$$

$$(18) \log A_t = \tau_0 + \pi \log A_{t-1} + \tau_1 \log GDP_t + \tau_2 \log PA_t + \tau_3 \log TV_t,$$

where lagged dependent variables are introduced as explanatory variables, and where π measures the velocity of adjustment to demand rigidities. Long-term elasticities for Model 18 can be calculated as follows (see Nerlove and Addison 1958, p. 864—865):

long-term income elasticity = $\tau_1/(1-\pi)$
long-term own price elasticity = $\tau_2/(1-\pi)$
long-term cross-price elasticity = $\tau_3/(1-\pi)$.

Long-term elasticities for Model 17 are calculated in the same way, excluding the cross-price elasticity term. The adjustment factor τ is assumed to be smaller than or equal to one, from which it follows naturally that long-term elasticities are greater than or equal to short-term elasticities. This is also consistent with economic theory. When τ is zero long-term and short -term elasticities of demand are equal, i.e., demand adjustment is instantaneous (less than a year).

In addition to estimating the above models, additional experiments have been undertaken with alternative ways of measuring certain variables to see, if the choice of the variable in question has any effect on the results. To study the possible effects of business cycles some of the models include a business cycle variable B.

After estimating the basic equations an attempt is made to simplify the model. The derived model — that is not known at this point — will then be estimated and compared with the often used dynamic consumption model.

$$(19) \log QH_t = \mu_0 + \pi \log QH_{t-1} + \mu_1 \log GDPH_t + \mu_2 \log PQ_t,$$

where QH is the quantity of newsprint (purchased annually by newspaper publishers) per household, GDPH is GDP per household, and PQ is the price of newsprint. At this level of consumption there are no relevant substitutes for newsprint but television advertising price variable TV is used as a substitute variable.

42. Estimation

Quite frequently in economic modeling the process under study can be best represented by a series of interdependent equations. In such cases there are alternative ways of estimating multi-equation models. The specified model here is recursive: each of the endogenous variables can be determined sequentially. Thus, it was decided to use the OLS estimator to estimate the model. The conditions for a proper application of OLS in the estimation of recursive models can be found, for example in Pindyck and Rubinfeld (1981).

When autocorrelation is present, residuals are analyzed to examine the possibility of an inappropriate functional form or an omitted explanatory variable. Only when the above sources of autocorrelation are ruled out, are regression models corrected for autocorrelation using the Cochrane-Orcutt estimator.

In cases where a (log-) linear function cannot be fully justified and a non-linear function must be estimated, Marquardt's method will be used (see Draper and Smith 1966, p. 272—273).

43. Evaluation criteria

The evaluation of a multi-equation model should depend on the purpose for which the model was built — just as in the case of single-equation models. Here, the primary purpose is analysis, hypothesis testing. Because of the analytical nature of the study the most important model evaluation criteria are the consistency of the individual equations with the postulates of economic theory and the observed behavior of economic variables, which mainly refer to the expected signs and magnitude of the parameters.

Individual equations are evaluated separately with respect to their statistical and econometric properties using the standard set of test statistics. The goodness of fit of an equation is measured by a multiple correlation coefficient adjusted by degrees of freedom, here noted simply by R^2. The F test is used to test the significance of the adjusted R^2 statistic. The statistical reliability of individual parameter estimates is measured by the t statistic. The significance levels of parameter estimates will also be reported.

Any harmful effects of multicollinearity there might be, are examined by looking at the simple correlations between pairs of explanatory variables relative to the R^2 (Farrar and Glauber 1967). The impact of multicollinearity is also analyzed by dropping one or more variables from the equation to see if the standard errors of the remaining variables are lowered. Correlation matrixes showing the paired correlation coefficients between all the variables of the model will be reported in the appendix.

First-order autocorrelation is tested by the Durbin-Watson (D-W) statistic (see e.g., Intriligator 1978, p. 161—165). The D-W test is not an appropriate measure of autocorrelation if there are lagged dependent variables among the explanatory variables. If autocorrelation is present in such cases the OLS estimation process will be both biased and inconsistent (e.g., Koutsoyiannis 1981, p. 307; Pindyck and Rubinfeld 1981, p. 193—194). Thus, to detect autocorrelation another test has to be used. The following test suggested by Durbin will be used here (see e.g. Pindyck and Rubinfeld 1981, p. 194—195):

$$(20) \quad h = \hat{\rho}\sqrt{\frac{T}{1 - T\,[\mathrm{var}(\hat{\beta})]}}$$

where T is the number of observations, $\mathrm{var}(\hat{\beta})$ is estimated as the square of the standard error of the coefficient of the lagged endogenous variable, and $\hat{\rho}$ is the estimated first-order serial correlation coefficient. The test for autocorrelation can be done by using the normal distribution table.

Estimation statistics of individual equations are not sufficient for evaluating a multi-equation model because even each individual model has, e.g., a good statistical fit, the model as a whole may perform poorly in reproducing the historical time series closely, or the converse may also be true (Pindyck and Rubinfeld 1981, p. 355). Here a central criterion is how well the newsprint consumption series produced by the system of models tracks its corresponding historical data series. Unfortunately this comparison cannot be carried out for the whole study period because of a lack of data. The standard error of regression in relation to the average of the dependent variable together with visual inspection are both used to evaluate the correspondence of the series.

44. Variables and sources of data

General statistical data were derived from several sources. The main sources were Joukkoviestintätilasto 1987 (Mass Media Statistics) published by the Central Statistical Office of Finland, Facts about Finnish Newspapers published by the Finnish Newspaper Publishers Association, and Advertising Expenditure in Finland published annually by Suomen Gallup Oy. Basic data are presented in Appendix 2.

All variables are expressed as index figures (1960 = 1) to eliminate the effect of differences in the unit of measurement. All monetary variables were deflated by the implicit price index of the gross domestic product with the exception of disposable household income which was deflated by the consumer price index.

The annual domestic sales of newsprint in tonnes, the price of newsprint per tonne (48.8 g/m^2) and the newsprint substance weight series were all obtained from Finnpap.

Data series for average newspaper subscription price, circulation, volume of newspaper advertising and the average price of advertising space were obtained from the Graphical Laboratory of the Technical Research Centre of Finland. These circulation figures include only newspapers appearing 3—7 times a week. The index of newspaper advertising volume originates from the Economic Department of the Ministry of Finance. The series excludes political advertising during election years. For the years 1960—1965 newspaper advertising rates published in a report by Mähönen (1975) were used by applying a chaining method.

It must be noted that the proper series describing newspaper advertising price/cost) development should be a weighted average of black-and-white and color advertisement rates, and that production costs of advertisements would be included in the cost index. Unfortunately, the official index for newspaper advertising prices describes only the price development of black-and-white advertisements. Data on the production costs of advertisements do not exist for the entire study period. However, it has been estimated that the real production costs of advertisements have not changed much, so the advertising rate series is not likely to be biased.

The series for the newsprint consumed annually by the newspapers and the combined annual page number for newspapers were obtained from the Finnish Newspaper Publishers Association. Total page data exist only for the years 1975—1986. For these years the average size of a newspaper was calculated by dividing the total number of pages by the annual number of newspapers, but the years 1960—1974 had to be estimated. A proxy for the average number of pages in a newspaper, 1960—1974, was constructed by "deflating" the average weight of a newspaper series by the index for average substance weight. The latter series represents the weight development of a single newspaper page. The average weight of a newspaper series was obtained from the Statistical Yearbook of the Board of Posts and Telecommunication. Because this series represents only newspapers distributed by mail, it underestimates the average page development because the fastest growing newspapers take care of distribution themselves.

Newspaper distribution costs are represented by the post tariff rate for newspapers (obtained from the Economic Department at the Board of Posts and Telecommunication) and by the calculated labor cost index. The wage series was derived by dividing the sum of employee and salaried wages in the industries "Newspaper Printing" (SIC 342011) and "Newspaper Publishing" (SIC 342041) by the aggregate man-hours paid. Data on nonproduction worker hours are missing for the period 1960—1972. The total man-hour series was constructed assuming that the amount of hours paid in a year per nonproduction worker was the same in 1960—1972 as in 1973, and multiplying this figure by the annual number of salaried workers.

Because data on supplemental benefits do not exist for the entire period, they had to be excluded from the labor cost calculations, even though their share of total labor costs has increased clearly from their level in the early 1960's. Because of the classification changes (small presses and publishers were combined in the statistics) in 1986, wage and employment hour data had to be estimated for this year using data on the aggregate industry "Printing and Publishing" (SIC 3420) and assuming that relative shares had stayed the same. The source for all labor cost data was Industrial Statistics published annually by the Central Statistical Office of Finland.

The price of television advertising (per second) was calculated using existing statistics and MTV's (Finnish commercial television company) yearbooks. Television advertising rate was calculated by dividing the total television advertising expenditures by the total time spent on advertising. Total expenditures were measured as a sum of MTV's total annual net advertisement sales and the production costs of commercials. For the years 1980—1986 total television advertising expenditure data existed in the publication Advertising Expenditures in Finland, but for the period 1960—1979 it was assumed that production costs were 15 percent of MTV's advertisement sales (in 1980—86 this share has varied between 15 and 20 percent). For some of the early years data on total advertising time do not exist. In such cases total advertising time (in seconds) was derived by multiplying the total number of spots by the average spot length (19.95 seconds in 1963).

The gross domestic product, disposable household income, consumer price index, and the number of households data were

obtained from the annual Statistical Yearbook and national accounting statistics both published by the Central Statistical Office of Finland.

The business cycle variable was computed by dividing the general index of export volume by the corresponding trend values. The trend values were obtained from the equation x = 103.8575 + 16.4255t, where t represents time.

5. Determinants of newsprint consumption

51. Basic models

According to the results obtained from the estimation of the recursive equation system, total newspaper circulation and newspaper advertising volume together with the factors affecting these two variables were found to be central in determining newsprint consumption. A third important factor affecting directly newsprint consumption is the change in the substance weight of newsprint.

The estimation of the recursive multi-equation model of newsprint consumption was started from Equation 11 explaining the variation in the (logarithm of) subscription price (P_t). The estimated parameters, i.e. the elasticities, t-values (t*) and significance levels are reported in a tabular form (Table 1) together with statistics R^2, D-W (Durbin h in some models) and F. Partial correlation matrix of explanatory variables of this model as well as the correlation matrixes of all the other models are presented in Appendix 3. Actual and fitted values of various estimated models are shown in Appendix 4.

According to this model, if all the cost components were to simultaneously increase by one percent, subscription price would be increased by more than one percent because the sum of elasticities amounts to 1.2. This result does not support the hypothesis that advertising income is used to subsidize *increased* production and delivery costs. Instead, it seems that increased costs are fully transferred to subscription prices.

All the individual coefficients are highly significant, have the right signs, and correspond quite well with the relative cost shares with one exception. The parameter estimate for the post tariff variable representing delivery costs (for newspapers using post delivery) is too large in relation to its relative cost share, and this may be the reason for the sum of elasticities adding up to more than one. Also, the coefficients of W and TA are not fully reliable for the entire study period, because instead of transferring increases in post tariffs to subscription prices several newspaper publishers — including the main newspapers — have responded by starting distributing their newspapers themselves.

To get information on factors affecting newspaper demand Equation 12b was estimated using the Cochrane-Orcutt method (because of the presence of positive autocorrelation in the original estimation (Table 2):

The estimation results reveal that increases in the real income affect the decision to subscribe to a newspaper (the first one, or an additional newspaper). A one percent increase in the real household disposable income would increase the ratio of newspapers per household (CIRH) by 0.23 percent, ceteris paribus. Small changes in subscription rates, on the other hand, seem to have no effect on the decision to subscribe. Demand for newspapers is price-inelastic: the sign of the subscription price parameter estimate is negative as expected but the coefficient is not significantly different from zero. This result supports the a priori hypothesis that newspapers are almost a necessity for Finnish readers. Price inelasticity of demand can also be explained by its small share of total household expenditures and lack of substitutes. The results obtained here are consistent with an earlier study by Mähönen (1975).

The estimation results of Model 12a, that is a kind of "industry" model, where the number of households is incorporated as an explanatory variable, are presented in Table 3. The coefficient of HH[—1] is the household elasticity of demand of newspapers (Note: an outlier was excluded, so one degree of freedom was lost),:

Because household elasticity of demand is approximately one, an increase in the number of households would result in an equal increase in the total circulation, other things being constant. Income elasticity of demand is slightly lower than in the previous model as expected because total disposable household income has been increasing at higher rates than household income per household. Contrary to expectations, price elasticity of the demand parameter is significant here (at 10 % risk level). The business cycle variable B was also tried out but the obtained parameter was not significant.

There is no first-order autocorrelation but multicollinearity exists to such an extent that it may affect the interpretation of individual coefficients. However, the fact that multicollinearity is not a problem in Model 12b, and that the coefficients are close to each other in both model variations, increase the weight we can place on the parameter estimates in Model 12a.

Estimation of Equation 13 explaining the formation of the average price of advertising space (PA_t) proved to be problematic because of very strong first-order autocorrelation suggesting that the wrong model specification had been used. Strong autocorrelation could be due to missing variables like publishing costs or increased availability and importance of other media. The relationship appears to be of a logistic form at least during the study period. This form of a function may be caused by a combination of changes in the competitive structure of the newspaper industry, and in the possibilities of transferring increased publishing costs into advertising prices. Cost increases were exceptionally great in the mid-70's, which may explain the rapid increases in newspaper advertising rates during the same period. However, to assume that the logistic functional relationship also holds outside the study period is not reasonable.

Table 1. The results of Model 11 for the period 1975—86, dependent variable is subscription rate P.

Independent variable	Coeff.	t*	Sig. level
Constant	—.0183	—1.050	.3050
Lagged newsprint price, PQ [—1]	.2269	3.076	.0055
Lagged post tariff, TA [—1]	.6019	9.282	.0000
Lagged wage rate, W [—1]	.3882	7.796	.0000

R^2 = .9740
F = 313.4
DW = 1.769

Symbols explained in the List of Variables.

Table 2. The results of Model 12b for the period 1961—86, dependent variable is circulation of newspapers per household CIRH.

Independent variable	Coeff.	t*	Sig. level
Constant	—.0333	—2.505	.0122
Lagged disp. income per household, YH [—1]	.2318	5.979	.0000
Endog. subscription rate, MP	.0131	—.607	.5437

DW = 2.305

Symbols explained in the List of Variables.

Table 3. The results of Model 12a for the period 1962—86, dependent variable is total circulation of newspapers CIR.

Independent variable	Coeff.	t*	Sig. level
Constant	—.0212	—3.212	.0042
Lagged number of households, HH [—1]	1.0075	5.780	.0001
Lagged disposable household income, Y [—]	.1707	3.024	.0065
Endog. subscription rate, MP	—.0713	—1.767	.0918

R^2 = .9954
F = 1727.4
DW = 1.593

Symbols explained in the List of Variables.

Table 4. The results of Model $\log PA_t = \mu_0 + \mu_1 MCIR_{t-1} + DUM1$ for the period 1963—86.

Independent variable	Coeff.	t*	Sig. level
DUM1	.2455	11.762	.0000
Endog. lagged total circulation, MCIR [—1]	.3024	28.705	.0000

R^2 = .9449
F = 395.3
DW = 1.548

Symbols explained in the List of Variables.

Table 5. The results of respecified Model 14 for the period 1963—86, dependent variable is newspaper advertising volume A.

Variable	Coeff.	t*	Sig. level
Constant	—.0106	—.158	.8756
Gross domestic product, GDP	.8214	7.379	.0000
Endog. price of newspaper advertising, MPA	—.2264	—.987	.3362
DUMGDP	.9017	4.912	.0001
DUMO	—.6487	4.363	.0003

R^2 = .9486
F = 107.2
DW = 1.441

Symbols explained in the List of Variables.

Nonlinear estimation was attempted but the results were not satisfactory. It was then decided to introduce a dummy variable (DUM1 = 0 before 1976, 1 during and after 1976) to account for the structural change taking place in the mid-1970's, and to estimate the function in a semi-log form. This improved all the aspects of the model. The final model was estimated without the constant term because it was not significantly different from zero: the exclusion of the constant improved the adjusted R^2, F- and D-W statistics (Table 4):

In the mid-1970's price of advertising space shifted to a new level as shown by the significant coefficient of the dummy variable. To explain this shift newspaper publishing cost variables were added to the model but the model did not improve. A specification including only these cost variables (as in Model 11) was also estimated but the results were uninterpretable in economic terms thus showing that circulation figures or coverage have more effect on newspaper advertising prices than newspaper production and distribution costs.

Another interpretation of these results is that the total circulation or coverage of an individual newspaper places limits on attempts to cover increased publishing costs through increasing advertising prices. Advertisers are not interested in the costs of newspaper publishing; they only want to know how large a share of their prospective clients they can reach using a certain newspaper as advertising media.

Newspaper advertising demand model (Equation 14) is the most central model in this equation system together with models 12a and 12b in explaining newsprint consumption determinants. The original model suffered from strong positive autocorrelation, and is was respecified by introducing both an intercept dummy variable and a slope dummy (both 0 before 1974, 1 during and after). The variable TV was excluded from the final estimation because its parameter estimate was approximately zero and its t-statistic was very low. The results of that model are presented in Table 5:

The strong autocorrelation in the first estimated model was probably caused by the incorrect assumption that the coefficients had stayed constant during the study period. The dummy variables in this model, however, are clearly significant and of magnitudes that imply that a structural change has taken place. The D-W statistic lies in the indeterminate area, but residual analysis revealed that autocorrelation is not likely to be present.

As a result of oil crisis and the consequent economic depression the volume of newspaper advertising dropped considerably in the mid-1970's. After the slump the propen-

Table 6. The results of respecified Model 15 for the period 1963—86, dependent variable is average newspaper size V.

Variable	Coeff.	t*	Sig. level
Constant	.0304	1.599	.1248
Endog. newspaper advertising volume, MA	.5117	7.992	.1248
DUM2	.1268	4.298	.0003

R^2 = .9312
F = 156.5
DW = 1.633

Symbols explained in the List of Variables.

sity to advertise has doubled: the GDP elasticity of newspaper advertising demand increased from 0.8 in 1963—1975 to 1.7 in 1976—1986 thus implying that newspaper advertising is a superior good. It can also be interpreted that the advertised goods are superior given that all the advertising costs can be transferred to product prices. Another interpretation is that the changed nature of competition has changed the advertising patterns. The latter elasticity corresponds quite well with the advertising volume development in the 1980's with respect to the GDP. It shows clearly that at present an increase in GDP produces an even greater increase in the volume of newspaper advertising, and this again, increases the demand for newsprint.

The price of advertising space variable had a negative sign, and they were of the same size (about —0.24) in both specifications, but quite unexpectedly they were not significant at any reasonable significance level. The sign of the television advertising price variable was positive suggesting that newspaper and television advertising are substitutes, but again, the parameters were not significant, so it appears that newspaper advertising is (relatively) independent from television advertising.

The discussion in the introductory chapters shows that one can accept that the cross price elasticity of demand for newspaper advertising is zero, and it is not reasonable to assume that the demand for newspaper advertising does not depend on its own price. This unexpected result may be caused by multicollinearity (Appendix 3). The paired correlation coefficient between MPA and GDP is about 0.9, and even if this is less than the adjusted R^2, parameter estimates may be harmfully affected.

Because estimation of Equation 14 with dummy variables implies an assumption that the error variances in both periods are equal, two separate regressions were run to allow for the error variance to vary. This was also done to see if the strong multicollinearity as evidenced by a high paired correlation coefficient between the two dummy variables affects the coefficients. The parameters and their standard errors stayed about the same, so the results presented in Table 5 can be considered reliable in this respect.

The volume of newspaper advertising is sometimes used as a proxy for a business cycle variable (e.g. by the Economic Department of the Ministry of Finance in Finland). However, when the business cycle variable B_t was included in several alternative variations of Equation 14 (variables were added one by one), in no case did it prove significant. This suggests that the construction of the business cycle variable did not succeed in this study.

The estimation results of Model 15 explaining the variations in the average size of a newspaper are shown in Table 6. The model was originally estimated without the dummy variable but the presence of positive autocorrelation in conjunction with a high R^2 suggested a mis-specification for the model. The inclusion of the dummy variable (0 before 1975, 1 during and after 1975) eliminated autocorrelation according to the D-W statistic, increased the adjusted R^2, and reduced the standard error of regression, but it did not have much effect on the advertising volume variable MA (a decrease from 0.72 to 0.51).

The results show that the variations in the average size of a newspaper can be explained by changes in the advertising volume. A ten percent increase in advertising volume measured by total advertising space, would increase the average number of pages by approximately five percent. On the other hand, it appears that the relationship between editorial pages and advertisement pages is not fixed 1 to 1.

Before proceeding to the last stage, i.e., to the determination of the amount of newsprint required by newspapers through Equation 16, a summary evaluation of the

estimated individual equations is made. The individual equations are consistent with the economic theory and with expectations concerning the signs and magnitudes of the derived parameters based on the observed behavior of economic agents. This gives support to the basic model structure describing the relationships underlying the demand for newsprint except that substitution effects between television and newspaper advertising proved to be insignificant.

The goodness of the models were tested on a one-by-one basis using a set of statistical tests and applying econometric criteria. All the individual equations (final specifications) except Equation 13 in the first half and Equation 15 during the last ten years fit the data well, and they are statistically significant. Multicollinearity is present in Model 13 to such an extent that it may affect the reliability of the results. Strong multicollinearity is also present in models 12b and 14, but additional analysis showed that it did not necessarily create any problems. Although in no case is multicollinearity deemed harmful on the basis of the Farrar-Glauber criterion, one should take great care in interpreting individual coefficients when paired correlation coefficients higher than 0.9 are found.

Standard errors of regressions were also small in relation to the averages of the dependent variables showing that the fitted values track quite closely the historical data series. This is a desired characteristic if a model is to be used for forecasting purposes. Visual inspection of the actual and fitted values shows also that fitted values follow turning points reasonably well almost without exceptions. Estimation of these equations using logarithmic differences reduced the adjusted R^2's considerably in most cases and changed also the magnitudes of estimated parameters, thus implying a strong "trend effect". Although the R^2's cannot directly be compared because the dependent variables are not the same, the estimation results in a difference form diminish the explanatory power of the original models. It especially renders the use of these models almost useless for short-term purposes, because so much of the short-term variation is left unexplained.

The newsprint consumption series is derived by applying Equation 16. Because consumption is not statistically estimated but an identity is used, model goodness cannot be statistically evaluated but graphical and other simple methods of analyzing the fit must be used. Unfortunately, because of problems with the quality of the data the evaluation, in spite of its importance, could not be carried out in an optimal way.

Because annual newsprint consumption data exist only for period 1975—1986, newsprint sales data have to be used as a proxy for consumption data for the entire study period. The suitability of this variable as a proxy for newsprint consumption is reduced by two factors: the effects of stock behavior cannot be analyzed because of a lack of data on stocks, and during the last ten years newsprint has been used increasingly for other purposes than printing newspapers, and vice versa. Changes in newsprint inventories only affect annual consumption behavior, so the long-term analysis should not be affected. Unfortunately, reliable and consistent data on the quantity of newsprint annually used for printing free delivery newspapers, local newspapers, insert sheets, etc. do not exist.

In Fig. 5 the derived newsprint consumption series is plotted together with the actual newsprint sales series after anti-logarithms were taken. The new base in these series is 1963.

This figure shows that the model succeeds relatively well in describing the overall development of newsprint consumption. However, the model quite consistently underestimates newsprint consumption. The annual fluctuations in the mid-70's and during 1981—86 are also not captured. The reason for this may be unaccounted stock behavior.

Another reason for underestimation may be that the variable APP in Equation 16 was assumed to be constant implying equality between the total circulation and total volume of newspapers. However, over several years the volume of newspapers has been growing faster than total circulation because the average number of appearance days (APP) has been increasing. Also, the circulation of daily newspapers has been growing the fastest. From the viewpoint of the logic of the model the choice of circulation for the dependent variable in Equation 12a was natural. On the other hand, it could be that newsprint consumption would have been better described by using the volume of newspapers instead, even though it does not

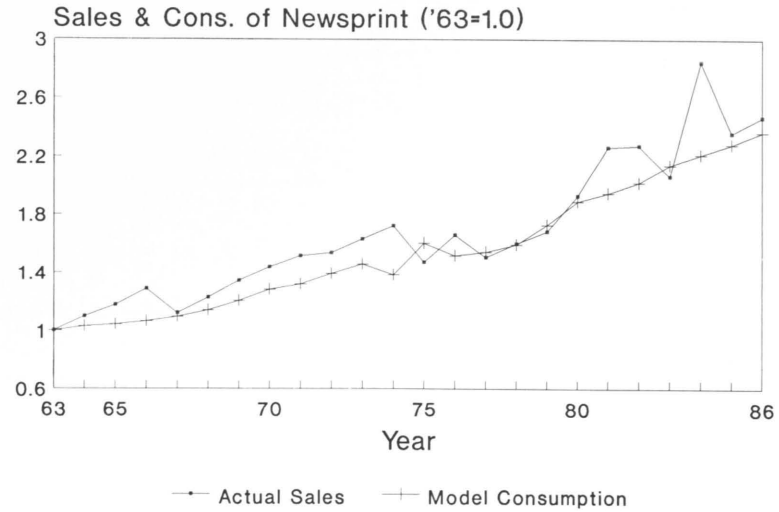

Figure 5. Model consumption and actual sales of newsprint, 1963—86.

fit the decision-making framework of a household.

The annual average growth percentages of actual newsprint consumption (sales) and model consumption were 4.0 percent and 3.8 percent for the period 1963—86, respectively. If we study the period 1975—86 separately, the corresponding growth rates are 4.8 percent and 3.6 percent showing that newsprint consumption was underestimated during this period.

When the derived consumption figures for newsprint are contrasted to the actual consumption figures for the same years the average annual growth rates move closer to each other (4.4 and 3.6 percent, respectively). The graph of these two series is depicted in Fig. 6. The differences may be explained by increased alternative uses of newsprint since the beginning of the 1980's.

It must be noted that the estimates for newsprint consumption in 1975—86 were obtained using the model estimated for the whole period. In Appendix 5, the estimation results of the recursive model for the years 1975—86 are presented, and the derived consumption series is then compared with actual consumption data for the same period.

To study the effect of the reduction in newsprint substance weight (AWP) on newsprint consumption, Equation 16 was recalculated assuming that AWP is constant. An annual increase in newsprint consumed would have been about one percent higher without the reduction in substance weight. For forecasting purposes it must be noted that the rate of reduction in substance weight has slowed down. For the period 1975—86 annual average growth rates of newsprint consumption with and without recognizing the effect of the changes in substance weight were 4 and 3.6 percent, respectively. These differences in the growth rates of newsprint consumption would naturally also apply to the actual consumption series.

52. Structural analysis

The problems in the estimation of some of the models in the recursive model system showed that the assumption of stable coefficients over time does not hold for all the models. These problems led to model specifications which allowed the coefficients to vary. Here, the constancy of individual parameters is studied in a simple way for each model. Regression models were run separately for periods 1960—1974 and 1975—1986, and the coefficients were then compared to study the possible differences in the elasticities between the two periods. All

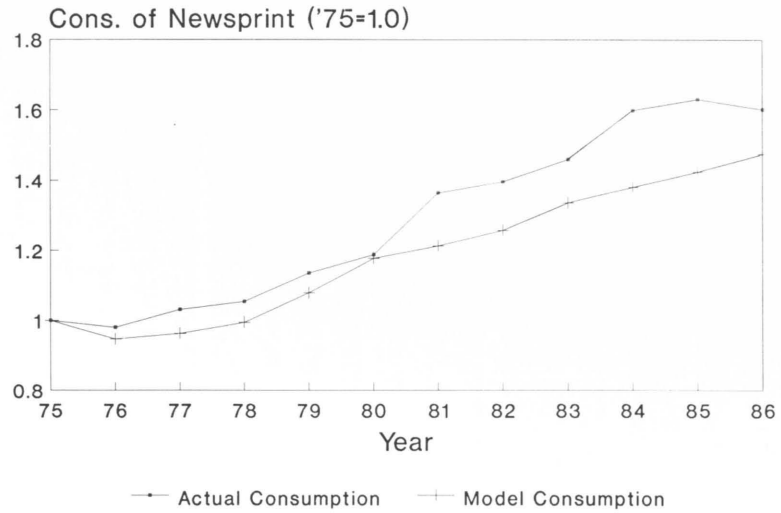

Figure 6. Model consumption and actual consumption of newsprint, 1975—86.

variables are assumed exogenous (recursive relationships are ignored here). The estimated models are in Appendix 6. The correlation matrixes of explanatory variables are in Appendices 7 and 8. The obtained parameters must be interpreted with care, because a small amount of degrees of freedom may give too much weight to single observations.

Model 11 does not describe well the variations in the subscription rate for the period 1961—74 as can be concluded from the wrong parameter signs (possibly due to multicollinearity) and serious autocorrelation. In the period 1975—86 the model has the correct signs, a very high R^2 and significant parameter estimates. There is no autocorrelation and multicollinearity is not a problem. When this model is compared with the model estimated for the whole period, the wage elasticity coefficient indicates that subscription rates have become more responsive for changes in wages towards the end of the study period. This is likely to be due to the fact that newspapers have started to deliver their papers themselves, which has increased the relative cost share of wages.

Estimation of Model 12b produced interesting results concerning changes in income and price elasticities of newspaper demand (Appendix 6). The income elasticity of newspaper demand has increased from 0.16 to 0.34 during the course of time. This is contrary to the common hypothesis that as incomes reach higher levels, income elasticity of *newsprint* demand would fall. Maybe the human need for more information strengthens at higher income levels.

It also appears that, at present, (small) changes in subscription rates do not affect decisions to subscribe, that is, newspaper demand is price-inelastic. On the other hand, the results suggest that in the 1960's and in the early 1970's people were more responsive to price changes, although demand was relatively inelastic. In 1961—74 the price elasticity of newspaper demand was —0.2608 (with a t-value of —2.139); in the latter period it was not significantly different from zero at any reasonable significance level. The D-W statistic in the model for the first period fell into the indeterminate region, but residual analysis revealed that autocorrelation is not likely to be present.

Estimation of Equation 12a yielded similar results with respect to income and price elasticities of newspaper demand. The household elasticity of demand increased from 0.77 to 1.1. For both models the D-W test was inconclusive, but residual diagnostics indicated that autocorrelation is not present. However, multicollinearity is present to such

an extent that the reliance we can place on the individual coefficients is reduced. On the other hand, the derived income and price elasticities of demand are of the same magnitude as in Equation 12b that does not suffer from multicollinearity.

Estimation of Equation 13 explaining the variation in real advertising rates separately for the two regimes revealed that the estimation problems for the whole period were due to the inability of the model to explain adequately the changes in real newspaper advertising rates during 1961—1974 (Appendix 6). The exceptional years in the mid-1970's could also not be explained satisfactorily with the model, so two of the earliest observations in the latter half had to be left out. For the period 1977—86 the estimated model is relevant according to economic, statistical and econometric criteria. However, because of the problems in running the regression for the early period, it is not possible to infer if the coefficient of the circulation variable has changed over time.

Estimation of the newspaper advertising demand model (Equation 14) for the whole study period showed that the assumption of constant GDP elasticity of demand is not realistic. Dummy variables were then used to capture the effects of the structural change. Estimation of the model for two separate periods yielded results and interpretations similar to these results. The D-W statistic indicated the presence of autocorrelation in the model for 1960—1974, and because the model specification appeared to be correct, the Cochrane-Orcutt estimation method was used.

According to the structural analysis the propensity to advertise in newspapers has increased from .83 to 1.64. This result is consistent with the result obtained in the estimation of the recursive model that accounted for the structural change. The cross price elasticity of demand is negative in the first period and positive in the latter but non-significant in both cases.

In the original model the price elasticity of newspaper advertising demand was not significant. Here the same was true for the years 1960—1974, but in the latter period the price elasticity of demand was elastic and significant (the coefficient of PA was —1.2734).

Estimation results of Equation 15 explaining the variations in the average size of a newspaper show that the coefficient of the advertising volume variable increased between 1960 and 1986. In the first period this elasticity was about 0.2, and in the latter period it had doubled after both the models had been corrected for autocorrelation (Appendix 6). This means simply that advertising has now more impact on the average size of the newspaper, i.e., on the number of pages than it used to have. Both models have quite large standard errors of regression, which diminishes the forecasting power of these models.

53. Long-term elasticities of demand

The estimated models of newspaper demand and newspaper advertising demand are static. The use of static models implies an assumption that the response to a given change in income or price is instantaneous meaning here that the adjustment takes place over one year. However, demand rigidities, of which habit formation is the most common one, do exist. Substitution induced by relative price changes takes time, too. Short-term elasticities of demand do not include the effects of demand rigidities, but they describe the relationship between the *instantaneous* demand response and the changes in the determinants of demand. Long-term elasticities of demand describe the relationship between the *total* change in demand and the demand determinants allowing more time for the adjustment process.

Dynamic formulations of models explaining newspaper demand and newspaper advertising demand (Equations 17 and 18, respectively) were estimated in this study, because of the assumed demand stickiness. According to the results in Tables 7 and 8 adjustments in demand do indeed occur, since the coefficients of the lagged dependent variables in both models are significant. This means that the original static models are not correctly specified.

According to the estimated equation the long-term income elasticity of newspaper demand is 0.2152 (0.1207/0.5608), that is about twice the size of the short-term elasticity. The long-term price elasticity of demand is —0.0191, but it is not likely significantly different from zero. Therefore, the dynamic model also shows that demand for newspapers is inelastic to small price

Table 7. The results of Model 17 for the period 1961—86, dependent variable is circulation of newspapers per household CIRH.

Variable	Coeff.	t*	Sig. level
Constant	—.0123	1.465	.1570
Lagged circulation per household, CIRH [—1]	.4392	2.213	.0376
Lagged disp. income per household, YH [—1]	.1207	2.659	.0143
Subscription rate, P	—.0107	—.783	.4419

R^2 = .8654
F = 54.55
DW = 1.812

Symbols explained in the List of Variables.

Table 8. The results of Model 18 for the period 1961—86, dependent variable is newspaper advertising volume A.

Variable	Coeff.	t*	Sig. level
Constant	.0188	.388	.7019
Lagged newspaper advertising vol., A [—1]	.5951	4.212	.0004
Gross domestic product, GDP	.5139	3.325	.0032
Price of newpaper advertising space, PA	—.2133	—1.403	.1753
Price of television advertising, TV	—.0187	—.334	.7419

R^2 = .9393
F = 97.67
DW = 1.491

Symbols explained in the List of Variables.

changes. These results indicate that *current* consumption of newspapers and disposable household income as well as future income play a role in the determination of *future* subscriptions by households.

Because the introduction of a lagged dependent variable amongst the explanatory variable is likely to bias the D-W statistic towards 2, the Durbin h statistic was calculated. This test was not valid, however, because $T^*Var(\hat{\beta})$ was greater than 1 (one cannot take a square root of a negative number), and another test proposed by Durbin had to be used (Pindyck and Rubinfeld 1981, p. 195). Based on this test it is concluded that first-order autocorrelation is not present, and the use of OLS is appropriate.

The estimation results of Model 18 analyzing the factors affecting the demand for newspaper advertising are shown in Table 8. Calculation of the Durbin h statistic indicates the absence of autocorrelation, and thus justifies the use of OLS. Multicollinearity may affect some of the coefficients (correlation matrixes of models 17 and 18 are given in Appendix 9).

The long-term elasticities of newspaper advertising demand were calculated from the coefficients in Table 8. The long-term GDP elasticity of demand is 1.2692 (0.5139/0.4049) implying that newspaper advertising is a superior good. This is the same result that was derived in the static model for the latter half of the study period. Price elasticity of demand is —0.5268 which indicates that given time for adjustment demand is considerably more elastic, or better put, less inelastic. Cross price elasticity of demand is not significantly different from zero at any reasonable risk level; the derived value is —0.0464.

The significant coefficients of the lagged advertising volume variable and of GDP indicate that the *current* level of newspaper advertising and general economic activity (GDP) together with the future GDP play a major role in determining *future* advertising volume. Compared to the corresponding static model, the main difference is that price elasticity of demand is significant in the dynamic formulation (at 10 % significance level). Although demand is quite price inelastic (elasticity is —0.24), this makes more economic sense than demand being completely inelastic. Comparison of the derived adjustment factors indicates that compared to subscribers advertisers adjust faster to changes in the economic environment.

6. Estimation of newsprint demand with single-equation models

The recursive model used in this study was meant for analyzing in detail the factors affecting newsprint consumption in the long-term. It is therefore natural that this approach has provided more information and insight into the newsprint demand process than the often used single-equation models which only use a few explanatory variables. It is equally clear that the approach used here can not really be used for practical purposes, e.g. when forecasting newsprint consumption in a given country, and moreover, when forecasting newsprint consumption at a global level. For such purposes the model should not have too many variables, data on the variables should be readily available, and preferably there should be only one equation. In this chapter, a simplified model based on the results presented above will be estimated and compared to Model 19 and variations based on it. The comparison is done to check if the models produce similar results, and to study under which conditions the results are likely to differ. The development of models for actual forecasting purposes is outside the scope of this study.

The variable to be explained is the *sales* of newsprint in Finland between 1961 and 1986. This allows the circumvention of some of the data problems discussed earlier, and allows the comparison to take place on a similar basis. The results obtained in this study together with the theoretical discussion have emphasized the importance of advertising volume (A) and the rate of household formation (HH) in the demand process for newsprint. Advertising affects the pagination, and the number of households is the main factor affecting newspaper circulation. A model incorporating these variables (here HH and A are exogenous) was then specified and estimated:

$$(21)\quad \log Q_t = a + b\log HH_{t-1} + c\log A_t.$$

The results are shown in Table 9 where SER is the standard error of regression, and the correlation matrix of explanatory variables is in Appendix 10. The model was also specified without the lag, but the specification with a lag yielded slightly better results. Lags are also useful in forecasting. According to this model the newsprint sales change by exactly the same percentage as does the number of households. The elasticity of newspaper advertising volume is 0.6.

Estimation of a dynamic newsprint demand model (Equation 19) using per household data and estimation of the specification

$$(22)\quad \log Q_t = \mu_0 + \pi\log Q_{t-1} + \mu_1\log GDP_t + \mu_2\log PQ_t$$

using aggregate data provided similar results with respect to GDP and price elasticities (compare Baudin and Lundberg 1985), so only results based on aggregate data will be presented. Estimation of Equation 22 did not yield a significant estimate for the lagged consumption variable giving thus no indication that a dynamic model would perform better in forecasting long-term newsprint demand than a static model. This also naturally means that short-term and long-term demand elasticities are equal. Therefore, in Table 10 only the results of the static version of Equation 22 will be shown.

Table 9. The results of Model 21 for the period 1961—86, dependent variable is newsprint sales Q.

Variable	Coeff.	t*	Sig. level
Constant	.0945	3.528	.0018
Lagged number of households, HH [—1]	1.0078	3.087	.0052
Newspaper advertising volume, A	.5902	3.189	.0041

R^2 = .9328
F = 174.5
DW = 2.371
SER = .0751

Symbols explained in the List of Variables.

Table 10. The results of Model 22 for the period 1961—86, dependent variable is newsprint sales Q.

Independent variable	Coeff.	t*	Sig. level
Constant	—.0309	—.792	.4363
Gross domestic product, GDP	.9720	16.158	.0000
Price of newsprint, PQ	—.1358	—1.163	.2566

R^2 = .9117
F = 136.4
DW = 1.577
SER = .0842

Symbols explained in the List of Variables.

Income elasticity of demand is almost unity, so the demand for newsprint rises by the same proportion as does the GDP. The price of newsprint does not seem to have any effect on its consumption. These results are very much similar to those of earlier studies, e.g. Åberg (1968), Suhonen (1984), Baudin and Lundberg (1985, 1987). The inclusion of the business cycle variable B did not improve the model, and neither did the addition of the television advertising variable TV (cross-elasticity of demand is not significantly different from zero). The latter result can be due to difficulties in studying substitution of electronic media for newspapers at the level where there are in fact no substitutes for newsprint, or it may be an indication that newspaper and television advertising are simply not related.

Comparison of models 21 and 22 shows that the model explaining the variation in newsprint sales with the development of the number of households and the volume of newspaper advertising performs slightly better. It has higher R^2 and F statistics, and D-W statistic is closer to 2 indicating no first-order autocorrelation. Furthermore, its standard error of regression is one percent smaller than the SER of Equation 23. A low standard error of regression is usually a better indication of forecasting power than a high R^2.

The detected multicollinearity in Equation 21 does not have to be a problem in forecasting, if the collinear relationship between the explanatory variables remains stable. Additional analysis showed that at least during the study period the relationship

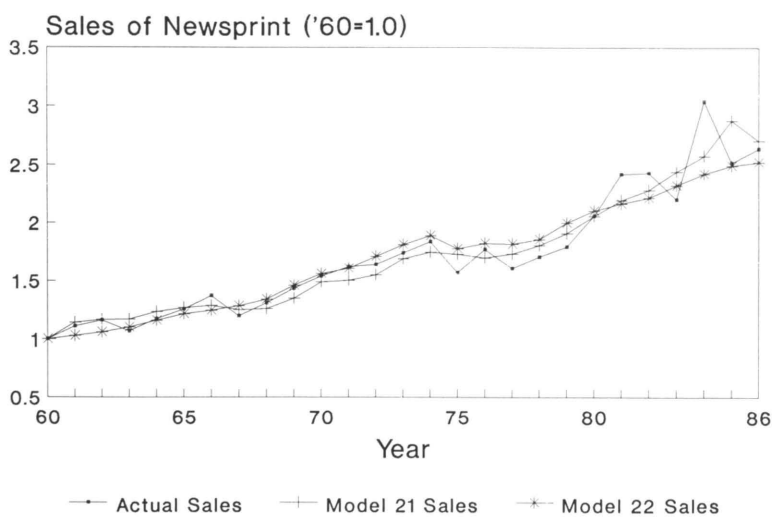

Figure 7. Fitted and actual newsprint sales, 1961—86.

between A and HH[—1] has stayed stable enough to justify the use of Model 21 in forecasting.

The differences between these two models with respect to statistical and econometric criteria are so small that it is not possible to choose one over the other. It could be argued that on theoretical grounds Model 22 is preferable because it can be derived from the newspaper publishers' production function given some assumptions about producer behavior. On the other hand, it does not allow the analysis of the actual driving forces of newsprint demand, e.g., the impact of advertising.

The comparison of the fitted values of these two models with actual newsprint sales also shows that both models have a good fit and follow turning points in newsprint sales quite well (Fig. 7). Model 21 with the number of households and newspaper advertising volume as explanatory variables however has the better fit of the two. The fit is recognizably better in the 1980's, and furthermore, Model 21 is able to track the turning point in 1984 (with a lag), which Model 22 is not capable of doing at all.

In practice, the application of Model 21 would require the use of an additional model to estimate newspaper advertising volume A. A reliable estimate for the rate of household formation would be easy to obtain, and there is no reason to expect substantial changes in the ratio of newspapers per household. The estimation of A would complicate the forecasting of future newsprint consumption, but on the other hand, it would permit direct account to be taken of the impacts on newsprint demand of developments affecting newspaper advertising volume. Also, it is always possible to make conditional forecasts based on alternative assumptions concerning A.

7. Summary and conclusions

In this study, factors affecting newsprint demand in Finland in 1960—1986 were analyzed. Based on the descriptive analysis of the industry, it was concluded that demand for newsprint cannot adequately be studied in isolation from the newspaper industry. A recursive multi-equation model was formulated and estimated to describe the newspaper industry and to obtain information on direct factors influencing newsprint consumption, emphasis being put on the decision-making process and the timing of decisions in purchasing newsprint and newspapers. The main three factors affecting newsprint consumption were found to be 1) total circulation of newspapers, 2) volume of newspaper advertising and 3) the change in newsprint substance weight.

Total newspaper circulation was found to depend on the rate of household formation and real (household disposable) income changes. The household elasticity of newspaper demand was estimated to be approximately one, and income elasticity of demand was about 0.2. Demand for newspapers was shown to be price-inelastic.

When interpreting the estimation results of the model(s) explaining newspaper circulation from the viewpoint of forecasting newspaper/newsprint consumption the following conclusions can be made. The rate of household formation is the most central variable affecting newspaper consumption given that the rates of household formation and real income growth do not change much in relation to each other in the near future. Changes in the real income level will also affect the demand for newspapers but the impact is smaller.

Structural analysis indicated that income elasticity of newspaper demand has increased slightly over time. This is contrary to the often stated hypothesis that as incomes reach higher levels income elasticity of newsprint demand, or of any paper product, would fall. Baudin and Lundberg (1987) also have found out recently that for newsprint and printing and writing paper the income elasticity differences between various income groups are not significant.

(Small) changes in real subscription prices do not have an impact on newspaper/newsprint demand. Consequently, changes in real newsprint prices are not likely to have much

effect on newspaper/newsprint demand.

The *volume of newspaper advertising* was shown to affect newsprint consumption via the effects on pagination. In the period 1960—74 the elasticity of this variable was 0.2, and in the latter period it doubled, thus implying that advertising has now more impact on the average size of a newspaper than before. Structural analysis of the factors affecting the volume of newspaper advertising revealed that the influence of GDP on advertising has increased in the course of time; the GDP elasticity of advertising demand was greater than one in the latter half of the study period. If this relationship holds in the future it means that an increase in GDP would produce an even greater increase in the volume of newspaper advertising. Structural analysis also revealed that advertising demand has become considerably more price-elastic over time. This could be due to the influx of competing advertising media.

However, according to this study newspaper advertising and television advertising are not related, i.e., the cross price elasticity of newspaper advertising demand is not significantly different from zero. This result does not support the claims that the fast growth of electronic communication media will negatively affect the demand for newspapers (as an advertising media). This may happen in the future, of course, but at least in the case of Finland, empirical results based on recent data do not indicate that electronic media has been substituted for printed media.

Newsprint substance weight was exogenous to the model, but its impact on newsprint demand was studied separately. The impact of the reduction in the basis weight has been quite substantial, but reduction will not be that great in the future. There is tendency to move to lower substance weights than the commonly used 45 g/m^2, but the needs of color printing tend to offset this change. One way to deal with the uncertainty concerning the substance weight in the future is to use e.g., Delphi or expert-panel consensus techniques to estimate the effects on newsprint demand.

Evaluation of the individual equations with respect to economic, statistical and econometric criteria supported the hypotheses included in the recursive model system. Multiple correlation coefficients are high, the standard errors of the equations are relatively low and the models fit the data well as evidenced by the graphs of actual and fitted values. However, modeling the price formation of newspaper advertising space was found to be quite troublesome suggesting that not all aspects of this process are known well enough. A lack of consistent data on the average size of a newspaper, or to be more specific, the lack of data on pagination also caused difficulties.

Although the individual equations in the model system perform "well", the model as a whole underestimates newsprint consumption. The reason for this underestimation is not likely to be in the recursive model but in the lack of reliable data on the circulation and the volume development of local newspapers and free delivery newspapers. During the last decade circulation (volume) growth of local newspapers and free delivery newspapers has been faster than that of ordinary newspapers. Data on the total number of pages have only been collected since 1975, and these data are based only on the members of the Finnish Newspaper Publishers Association. The reliability of a comparison between the newsprint consumption series based on the model and on the actual data is partly reduced because of the lack of compatible data for the entire study period.

The growing importance of free delivery newspapers and inserts made of newsprint means that they are already now factors that have to be taken into account when making newsprint demand forecasts (see e.g., Rennel 1987, Harris 1989). This again implies that more effort has to be put into collecting data on these variables. The problem at least in Finland is that free delivery newspapers, direct advertisers, and also local newspaper publishers do not keep proper statistics.

The estimation of long-term elasticities of demand for newspapers and newspaper advertising using dynamic models revealed that demand rigidities exist. Future consumption of newspapers was shown to depend on the current consumption of newspapers and the level of disposable household income. The future advertising volume is again dependent on the present level of newspaper advertising and general economic activity.

Estimation of the models in the logarithmic difference form to reduce or eliminate the multicollinearity problems revealed that the model system is not capable of explaining short-term variations in newsprint demand. Individual equations had low multiple correlation coefficients and several parameters had high standard errors. These results also cast a shadow of doubt on the causal reasoning on which the model is based. It can be argued, however, that the logic of the hypotheses cannot be questioned on the basis of the estimation results in a logarithmic difference form only.

A single-equation model explaining the sales of newsprint with changes in the volume of newspaper advertising and the number of households was estimated. It did not bring any significant improvements when compared to the often used dynamic demand model with income and price of newsprint as explanatory variables. Both models had good fits and followed turning points well. The implications of these two models differ considerably, however. The first model emphasizes a noneconomic variable, the rate of household formation, as a major newsprint consumption determinant, while the second model emphasizes the GDP. Results gave no indication that a dynamic model would perform better in forecasting long-term newsprint consumption than a static model.

Using the approach proposed in the study would also complicate forecasting slightly because it would entail an estimation of an additional equation, but on the other hand, it would permit direct account taken of the impacts on newsprint demand of developments affecting newspaper advertising volume. Here, demand for newspaper advertising was estimated as a function of the price of newspaper advertising, GDP and the price of television advertising. Data on these variables are readily available in Finland, and should also be available in most developed countries, so estimation of newspaper advertising demand is possible.

This case study of Finland proposes three reasons why newsprint demand has not shown clear signs of reaching a saturation level. Firstly, although population growth has stagnated in major consuming countries, the number of households has been increasing continuously. Secondly, income elasticity of newspaper demand does not show a declining trend. Thirdly, and most importantly, the main driving force behind the buoyant demand is the resurgence of demand for newspapers as an advertising medium. An increasing share of the GDP has been taken by the advertising sector. Newspapers have fared quite well in the competition for advertising shares, and they also have some inherent characteristics that favor them as advertising medium.

Although the analysis of the Finnish data does not support the saturation hypothesis, eventually the demand for newspapers must reach a saturation level. It must, however, be recognized that even in those countries where newspaper circulation reaches a saturation level, this does not automatically result in the saturation of newsprint demand because pagination may still increase long into the future. Also, globally — especially in the Third World and in Eastern European countries — there is still a huge potential for newspapers as an information and advertising media. Given the recent political developments in Eastern Europe, the *potential* demand for newsprint is likely to increase enormously in these countries as a result of liberalization of the press and freedom of expression. Advertising in these countries is also almost non-existent at present.

The role of newspaper as a source of information and as an advertising media differs not only between developed and developing countries, but also inside developed countries. In global and regional studies these various differences have often been captured by dummy variables. Given a large number of countries the use of dummies is practical, but also uninformative. In addition, these type of models produce relatively good results at a global or regional level, but they perform poorly at a national level. In practical forecasting work it does not really matter if e.g., the development in the advertising sector is taken quantitatively into account, or if newsprint consumption forecasts based on standard demand models are adjusted subjectively. However, subjective adjustments are likely to give erroneous results, if the demand process for newsprint is not fully recognized (see Graff 1983, Oliver 1985).

Models based on the use of trend functions or models based on economic growth alone are likely to produce erroneous forecasts. If reliable newsprint consumption forecasts are desired, in addition to projections of economic growth, attention must be paid to the rate of household formation, the

development of the advertising sector, the factors affecting competition between alternative media and the resulting media-mix in advertising, and changes in the substance weight as has been done by e.g. Jaakko Pöyry Oy (see Uutela 1989). Differences in these factors offer plausible explanations for differences in the levels of per capita consumption of newsprint in different countries. One possibility for improving global and regional forecasts would then be to use a more detailed approach paying attention to the above mentioned factors for major consumers, while, simple models with the GDP and price as explanatory variables would be used for the other countries.

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Total of 62 references

Appendix 1. Data on newspapers, local newspapers, and free delivery newspapers.

	Newspapers			Local Newspapers			Free Delivery Newspapers	
Year	Number	Cir*	Vol*	Number	Cir*	Vol*	Number	Vol*
1960	99	1.8	588.9	67	.2	18		
61		1.9	601.8			19		
62		1.9	614.9			21.5		
63		1.9	616.8			24		
64		1.9	625.5			26.5		
65	87	2.0	641.4	109	.4	29.8		
66		2.0	653.6			32.5		
67		2.0	651.5			35		
68		2.1	664.2			37.9		
69		2.1	671.1			38.5		
1970	87	2.2	691	129	.5	39.2		
71	88	2.2	703.9	130	.5	39.9		
72	90	2.4	722.6			41		
73	92	2.4	735.5	128	.6	42	45	35
74	93	2.5	755.7		.6	43		
75	89	2.5	757.7	136	.7	46		
76	90	2.5	759.9		.7	46		
77	88	2.5	757	137	.7	46		
78	89	2.6	780.7	137	.7	46		
79	89	2.6	802	140	.8	50	88	95
1980	91	2.8	783.3	146	.8	53		
81	94	2.9	870.5	153	.9	56		149.2
82	95	2.9	879.1	159	.9	61		156.7
83	95	3.0	902.5	166	1	68		228.8
84	98	3.0	916.7	170	1	69	131	
85	101	3.1	938	170	1	75		
1986	101	3.2	954.5	169	.9	77		

*Circulation and volume figures are in millions of copies.

Data sources: Joukkoviestintätilasto 1987
Paikallislehdisto
Facts about Finnish Newspapers
PTL:n tutkimus- ja tilastoaineisto

Appendix 2. Basic data in index form. (Symbols explained in the List of Variables).

YEAR	A	PA	TV	TA	P	W	PQ	YH	Y	GDP
1960	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
1961	1.0698	1.0936	1.2790	.9497	.9778	1.0109	1.0334	1.0970	1.1140	1.0689
1962	1.0814	1.2451	1.8867	.9131	.9516	1.0368	1.0065	1.1234	1.1582	1.0962
1963	1.0581	1.2896	2.2059	.8685	.9649	1.0631	.9574	1.1462	1.1995	1.1327
1964	1.1279	1.3259	2.9112	.9677	.9929	1.1054	.9275	1.1628	1.2349	1.1900
1965	1.1512	1.4261	4.5245	1.0051	1.0078	1.1570	.9049	1.1873	1.2794	1.2451
1966	1.1512	1.4516	5.0523	1.0233	1.0186	1.1987	.8853	1.2228	1.3366	1.2746
1967	1.0698	1.4768	5.2791	.9531	.9943	1.2457	.8439	1.2266	1.3598	1.3053
1968	1.0581	1.4845	4.4158	.9273	.9517	1.2390	.7616	1.2280	1.3804	1.3447
1969	1.1628	1.4433	4.1494	.8904	.9664	1.3446	.7313	1.3276	1.5130	1.4565
1970	1.3372	1.3898	3.7567	.8574	.9404	1.4728	.7041	1.4065	1.6247	1.5527
1971	1.3256	1.3869	4.0924	.7966	.9319	1.4791	.6542	1.4372	1.6875	1.5852
1972	1.3605	1.3826	4.2985	.8071	.9335	1.5251	.6791	1.5440	1.8423	1.6993
1973	1.5349	1.3538	4.3351	.7707	.9184	1.6031	.6735	1.5799	1.9150	1.8001
1974	1.5814	1.4212	3.7297	.8219	.8633	1.6587	.6284	1.6598	2.0435	1.8610
1975	1.5116	1.6552	4.0621	.8999	.9966	1.7422	1.0121	1.6800	2.1003	1.8708
1976	1.4302	1.8044	4.5176	.9592	1.1252	1.8909	.8986	1.6030	2.0717	1.8876
1977	1.3953	1.9343	5.0393	1.2927	1.2861	1.9191	.9401	1.5111	2.0167	1.8934
1978	1.4186	1.9815	5.5421	1.2974	1.4475	1.9557	.9626	1.5624	2.1101	1.9421
1979	1.5233	2.0024	5.8255	1.3066	1.4600	2.0051	.9487	1.6101	2.2419	2.0863
1980	1.6395	2.0376	5.7672	1.3679	1.4838	2.0472	.9530	1.6259	2.3109	2.2045
1981	1.7674	2.0387	6.2206	1.4719	1.4603	2.1666	.8774	1.5857	2.3074	2.2433
1982	1.8140	2.0792	7.2549	1.5158	1.5725	2.2670	.9316	1.6346	2.4339	2.3169
1983	1.9535	2.0967	7.4801	1.5807	1.7053	2.3102	.8495	1.6727	2.5186	2.3975
1984	2.1047	2.0508	7.7410	1.5699	1.7180	2.3567	.7867	1.6859	2.5667	2.4768
1985	2.4884	2.1087	7.8285	1.5745	1.8164	2.4474	.8029	1.6915	2.6305	2.5620
1986	2.1628	2.1637	7.7381	1.6515	1.7832	2.5402	.8503	1.6765	2.6633	2.6153

YEAR	GDPH	CIR	CIRH	HH	Q	QH	CQ	B	AWP	V
1960	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000		1.0000	1.0000	1.0000
1961	1.0526	1.0156	1.0001	1.0155	1.1100	1.0930		.9323	1.0225	1.0225
1962	1.0632	1.0312	1.0001	1.0310	1.1638	1.1288		.8739	1.0449	1.0449
1963	1.0823	1.0468	1.0002	1.0465	1.0678	1.0203		.8033	1.0449	1.0449
1964	1.1205	1.0623	1.0003	1.0621	1.1730	1.1044		.7838	1.0674	1.0674
1965	1.1555	1.0778	1.0002	1.0776	1.2571	1.1666		.7556	1.1011	1.1011
1966	1.1661	1.0988	1.0053	1.0931	1.3740	1.2570		.7389	1.1011	1.1011
1967	1.1775	1.1198	1.0101	1.1086	1.1985	1.0811		.7347	1.1124	1.1124
1968	1.1963	1.1408	1.0149	1.1241	1.3112	1.1665		.7596	1.0899	1.0899
1969	1.2781	1.1618	1.0195	1.1396	1.4347	1.2589		.8349	1.0899	1.0899
1970	1.3442	1.1829	1.0240	1.1551	1.5367	1.3304		.8287	1.1685	1.1685
1971	1.3501	1.2106	1.0310	1.1741	1.6209	1.3805		.7623	1.2135	1.2135
1972	1.4242	1.2857	1.0776	1.1932	1.6426	1.3766		.8232	1.2360	1.2360
1973	1.4850	1.3130	1.0832	1.2122	1.7426	1.4376		.8400	1.2697	1.2745
1974	1.5115	1.3559	1.1013	1.2312	1.8369	1.4920		.8006	1.1461	1.2810
1975	1.4964	1.3560	1.0846	1.2502	1.5722	1.2576	1.0000	.6322	1.2247	1.3719
1976	1.4605	1.3915	1.0767	1.2924	1.7720	1.3711	.9796	.7070	1.0899	1.3765
1977	1.4187	1.3945	1.0449	1.3346	1.6075	1.2045	1.0304	.7477	1.0562	1.3853
1978	1.4380	1.4218	1.0528	1.3506	1.7090	1.2654	1.0524	.7660	1.1236	1.4270
1979	1.4984	1.4484	1.0402	1.3924	1.7965	1.2902	1.1362	.8088	1.1573	1.5277
1980	1.5511	1.5316	1.0776	1.4213	2.0588	1.4485	1.1877	.8449	1.2360	1.3994
1981	1.5417	1.5842	1.0887	1.4551	2.4151	1.6597	1.3636	.8407	1.2472	1.5638
1982	1.5561	1.6121	1.0827	1.4890	2.4274	1.6302	1.3962	.7872	1.2697	1.7157
1983	1.5922	1.6413	1.0900	1.5057	2.2004	1.4614	1.4600	.7933	1.3258	1.8848
1984	1.6269	1.6471	1.0819	1.5224	3.0397	1.9966	1.5981	.8407	1.4045	1.6667
1985	1.6474	1.7043	1.0959	1.5551	2.5183	1.6194	1.6302	.8237	1.4157	1.7026
1986	1.6463	1.7240	1.0853	1.5886	2.6367	1.6598	1.6016	.8077	1.4045	1.7327

Appendix 3. Correlation matrix for explanatory variables in the basic models.

Model	11, 1961-86			12b, 1961-86		12a, 1962-86			13, 1963-86		14, 1963-86				15, 1963-86	
Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
PQ[-1]	1.00															
TA[-1]	.37	1.00														
W[-1]	-.14	.71	1.00													
MP				1.00												
YH[-1]				.65	1.00											
HH[-1]						1.00										
Y[-1]						.97	1.00									
MP						.92	.81	1.00								
MCIR[-1]									1.00							
DUM1									.87	1.00						
GDP											1.00					
MPA											.90	1.00				
DUMGDP											.84	.93	1.00			
DUM0											.81	.93	.98	1.00		
MA															1.00	
DUM1															.76	1.00

Symbols explained in the List of Variables.

Appendix 4. Actual and fitted values of the endogenous variables.

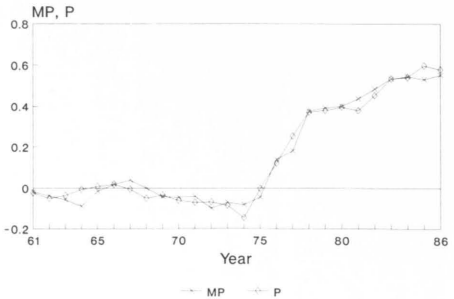

Figure 1. Endogenous (MP) and actual subscription rate of newspapers (P).

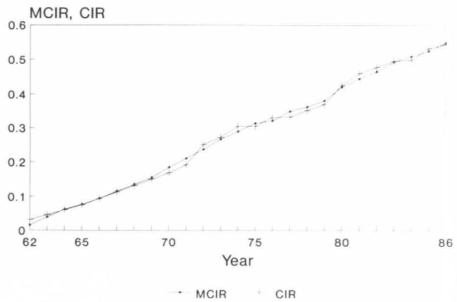

Figure 2. Endogenous (MCIR) and actual circulation of newspapers (CIR).

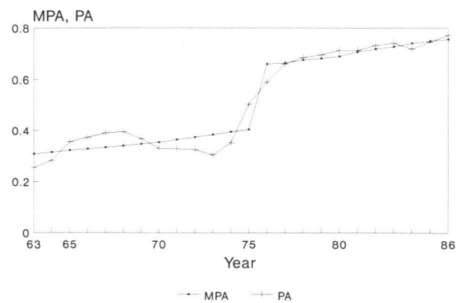

Figure 3. Endogenous (MPA) and actual price of newspaper advertising space (PA).

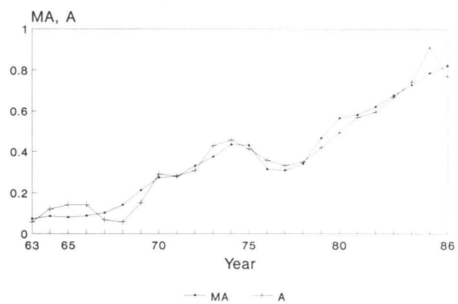

Figure 4. Endogenous (MA) and actual newspaper advertising volume (A).

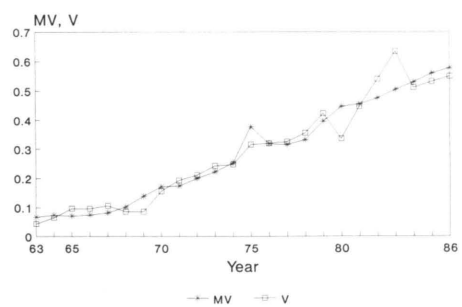

Figure 5. Endogenous (MV) and actual average size of newspapers (V).

Appendix 5. Recursive model for the period 1975—1986.

Structural analysis indicated that the estimated equations can not reliably be used for forecasting, or for analyzing the present and the near past, because the coefficients have changed over time. Because the same argument applies to the entire recursive model, the model system was estimated also for the years 1975—86, despite the small number of degrees of freedom. The model to be presented is not truly recursive, because exogenous values for the price of advertising space variable (PA) had to be used due to difficulties in estimating that variable and the small number of degrees of freedom in the last three models.

The model explaining the variation in the average subscription rate (P_t) indicates that the impact of newsprint cost on the subscription price has been reduced, whereas, the coefficient of the wage variable (W) has increased (Table 1) compared to the base model.

The estimation results of Model 12a explaining total circulation are similar to the model for the whole study period. The price elasticity of newspaper demand is not significant (Table 2).

In the estimation of Model 14, exogenous values of PA were used due to the above mentioned reasons. The estimation results of this model have been interpreted in detail in Chapter 52. Here, it will suffice to note that according to this model demand for newspaper advertising is elastic, the GDP elasticity is greater than one, and that newspaper and television advertising are not likely to be related, although the sign of the cross price elasticity of demand is positive (Table 3).

The estimation of Equation 15 explaining the average size of a newspaper showed that the impact of advertising has remained stable. The coefficient of the advertising volume variable MA is 0.51; is the same as in the regression for the entire period (Table 4).

The newsprint consumption series was calculated using Equation 16. The graph of this series and the original consumption series is depicted in Fig. 1.

When compared to Fig. 5 in the text, it can be observed that the recursive model for 1975—86 does not underestimate newsprint consumption in the early 1980's as much as the model for the entire period. However, underestimation of newsprint consumption is apparent.

Table 1. The results of Model 11 for the period 1975—86, dependent variable is subscription rate P.

Independent Variable	Coeff.	t*	Sig. level
Constant	.1546	5.312	.0007
Lagged newsprint price, PQ[-1]	.1296	1.669	.1336
Lagged post tariff, TA[-1]	.3477	2.937	.0188
Lagged wage rate, W[-1]	.8451	3.836	.0050

R^2 = .9736
F = 136.4
DW = 1.758

Symbols explained in the List of Variables.

Table 2. The results of Model 12a for the period 1976—86, dependent variable is total circulation of newspapers CIR.

Independent Variable	Coeff.	t*	Sig. level
Constant	.0190	.671	.5209
Lagged number of households, HH[-1]	.9808	2.270	.0529
Lagged disposable household income, Y[-1]	.2604	1.739	.1203
Endogenous subscription rate, MP	-.0887	-.691	.5090

R^2 = .9831
F = 213.9
DW = 1.839

Symbols explained in the List of Variables.

Table 3. The results of Model 14 for the period 1975—86, dependent variable is newspaper advertising volume A.

Independent Variable	Coeff.	t*	Sig. level
Constant	.1257	1.291	.2328
Gross domestic product, GDP	1.6467	4.145	.0032
Price of newspaper advertising, PA*	-1.2734	-2.453	.0397
Price of television advertising, TV	.2589	.838	.4262

R^2 = .9344 Symbols explained in the List of Variables.
F = 53.2
DW = 2.473

*Note: PA is exoneous in this model.

Table 4. The results of Model 15 for the period 1975—86, dependent variable is average newspaper size V.

Independent Variable	Coeff.	t*	Sig. level
Constant	.1451	7.426	.0000
Endog. newspaper advertising volume, MA	.5104	4.899	.0006

R^2 = .7069 Symbols explained in the List of Variables.
F = 27.53
DW = 1.735

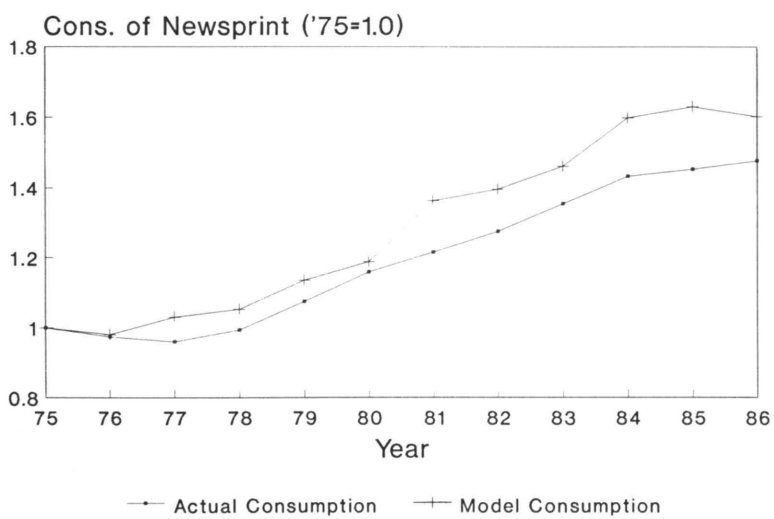

Figure 1. Model consumption and actual consumption of newsprint, 1975—86.

Appendix 6. Regression models for periods 1961—1974 and 1975—1986.

Table 1A. THe results of Model 11 for the period 1961—74, dependent variable is subscription rate P.

Independent Variable	Coeff.	t*	Sig. level
Constant	.0056	.462	.6541
Lagged newsprint price, PQ[-1]	-.1986	-1.068	.3106
Lagged post tariff, TA[-1]	.2900	2.449	.0343
Lagged wage rate, W[-1]	-.2748	-1.429	.1835

R^2 = .6581 Symbols explained in the List of Variables.
F = 9.344
DW = .8581

Table 1A*. The results of Model 11 for the period 1961—74, dependent variable is subscription rate P.

Independent Variable	Coeff.	t*	Sig. level
Constant	.0277	1.107	.2685
Lagged newsprint price, PQ[-1]	-.2771	-1.913	.0557
Lagged post tariff, TA[-1]	.2696	2.221	.0264
Lagged wage rate, W[-1]	-.4257	-2.902	.0037

DW = 1.726 Symbols explained in the List of Variables.

* The Cochrane-Orcutt estimation method was used.

Table 1B. The results of Model 11 for the period 1975—86, dependent variable is subscription rate P.

Independent Variable	Coeff.	t*	Sig. level
Constant	-.2916	-2.276	.0524
Lagged newsprint price, PQ[-1]	.1296	1.669	.1336
Lagged post tariff, TA[-1]	.3477	2.937	.0188
Lagged wage rate, W[-1]	.8451	3.836	.0050

R^2 = .9736 Symbols explained in the List of Variables.
F = 136.4
DW = 1.758

Table 2A. The results of Model 12b for the period 1961—74, dependent variable is circulation of newspapers per household CIRH.

Independent Variable	Coeff.	t*	Sig. level
Constant	-.0232	-3.411	.0058
Lagged disp. income per household, YH[-1]	.1650	4.198	.0015
Subscription rate, P	-.2608	-2.139	.0557

R^2 = .8635 Symbols explained in the List of Variables.
F = 42.1
DW = 1.665

Table 2B. The results of Model 12b for the period 1975—86, dependent variable is circulation of newspapers per household CIRH.

Independent Variable	Coeff.	t*	Sig. level
Constant	-.1030	-1.850	.0973
Lagged disp. income per household, YH[-1]	.3436	3.007	.0148
Subscription rate, P	.0215	1.007	.3401

R^2 = .4381 Symbols explained in the List of Variables.
F = 5.288
DW = 1.834

Table 3A. The results of Model 12a for the period 1961—74, dependent variable is total circulation of newspapers CIR.

Independent Variable	Coeff.	t*	Sig. level
Constant	-.0091	-1.207	.2550
Lagged number of households, HH[-1]	.7668	1.854	.0934
Lagged disposable household income, Y[-1]	.1870	1.348	.2074
Subscription rate, P	-.2653	-1.967	.0775

R^2 = .9792 Symbols explained in the List of Variables.
F = 205.4
DW = 1.667

Table 3B. The results of Model 12a for the period 1975—86, dependent variable is total circulation of newspapers CIR.

Independent Variable	Coeff.	t*	Sig. level
Constant	-.0644	-1.438	.1885
Lagged number of households, HH[-1]	1.1080	3.633	.0067
Lagged disposable household income, Y[-1]	.2038	1.566	.1559
Subscription rate, P	-.1180	-1.457	.1832

R^2 = .9858 Symbols explained in the List of Variables.
F = 255.9
DW = 2.417

Table 4A. The results of Model 13 for the period 1961—74, dependent variable is the price of newspaper advertising space PA.

Independent Variable	Coeff.	t*	Sig. level
Constant	.2583	7.583	.0000
Lagged newspaper circulation, CIR[-1]	.4645	1.915	.0796

R^2 = .1703 Symbols explained in the List of Variables.
F = 3.668
DW = .4321

Table 4B. The results of Model 13 for the period 1977—86, dependent variable is the price of newspaper advertising space PA.

Independent Variable	Coeff.	t*	Sig. level
Constant	.5494	20.480	.0000
Lagged newspaper circulation, CIR[-1]	.3918	6.336	.0002

R^2 = .8130 Symbols explained in the List of Variables.
F = 40.14
DW = 1.796

Note: two earliest observations excluded.

Table 5A. The results of Model 14 for the period 1960—74, dependent variable is newspaper advertising volume A.

Independent Variable	Coeff.	t*	Sig. level
Constant	.0410	1.079	.3037
Gross domestic product, GDP	.8157	8.612	.0000
Price of newspaper advertising space, PA	-.2760	-.610	.5545
Price of television advertising, TV	-.0249	-.232	.8210

R^2 = .8822 Symbols explained in the List of Variables.
F = 35.9
DW = 1.045

Table 5A*. The results of Model 14 for the period 1960—74, dependent variable is newspaper advertising volume A.

Independent Variable	Coeff.	t*	Sig. level
Constant	.1326	.564	.5726
Gross domestic product, GDP	.8313	3.903	.0001
Price of newspaper advertising space, PA	-.5560	-.994	.3200
Price of television advertising, TV	-.0117	-.112	.9108

DW = 1.705 Symbols explained in the List of Variables.

* The Cochrane-Orcutt estimation method was used.

Table 5B. The results of Model 14 for the period 1975—86, dependent variable is newspaper advertising volume A.

Independent Variable	Coeff.	t*	Sig. level
Constant	-.3320	-2.340	.0474
Gross domestic product, GDP	1.6467	4.145	.0032
Price of newspaper advertising space, PA	-1.2734	-2.453	.0397
Price of television advertising, TV	.2589	.838	.4262

R^2 = .9344 Symbols explained in the List of Variables.
F = 53.2
DW = 2.473

Table 5B*. The results of Model 14 for the period 1975—86, dependent variable is newspaper advertising volume A.

Independent Variable	Coeff.	t*	Sig. level
Constant	-.2564	-1.203	.2290
Gross domestic product, GDP	1.7284	4.340	.0001
Price of newspaper advertising space, PA	-1.4613	-2.364	.0181
Price of television advertising, TV	.2254	-.767	.3850

DW = 2.239 Symbols explained in the List of Variables.

* The Cochrane-Orcutt estimation method was used.

Table 6A. The results of Model 15 for the period 1960—74, dependent variable is average newspaper size V.

Independent Variable	Coeff.	t*	Sig. level
Constant	.0198	1.871	.0840
Newspaper advertising volume, A	.5294	11.182	.0000

R^2 = .8986 Symbols explained in the List of Variables.
F = 125.0
DW = 1.123

Table 6A*. The results of Model 15 for the period 1960—74, dependent variable is newspaper size V.

Independent Variable	Coeff.	t*	Sig. level
Constant	.4022	2.201	.0278
Newspaper advertising volume, A	.2059	2.325	.0201

DW = 1.438 Symbols explained in the List of Variables.

* The Cochrane-Orcutt estimation method was used.

Table 6B. The results of Model 15 for the period 1975—86, dependent variable is average newspaper size A.

Independent Variable	Coeff.	t*	Sig. level
Constant	.1779	2.894	.0160
Newspaper advertising volume, A	.4759	4.503	.0011

R^2 = .6367 Symbols explained in the List of Variables.
F = 20.28
DW = 1.560

Table 6B*. The results of Model 15 for the period 1975—86, dependent variable is average newspaper size V.

Independent Variable	Coeff.	t*	Sig. level
Constant	.2165	2.727	.0064
Newspaper advertising volume, A	.4208	3.212	.0013

DW = 1.956 Symbols explained in the List of Variables.

* The Cochrane-Orcutt estimation method was used.

Appendix 7. Correlation matrix for structural models, 1961—74.

Model	11, 1961-74			12b, 1961-74		12a, 1961-74			14, 1961-74		
Variable	1	2	3	4	5	6	7	8	9	10	11
PQ[-1]	1.00										
TA[-1]	.75	1.00									
W[-1]	-.97	-.76	1.00								
P				1.00							
YH[-1]				-.76	1.00						
HH[-1]						1.00					
Y[-1]						.99	1.00				
P						-.71	-.75	1.00			
GDP									1.00		
PA									.61	1.00	
TV									.69	.96	1.00

Symbols explained in the List of Variables.

Appendix 8. Correlation matrix for structural models, 1975—86.

Model	11, 1975-86			12b, 1975-86		12a, 1975-86			14, 1975-86		
Variable	1	2	3	4	5	6	7	8	9	10	11
PQ[-1]	1.00										
TA[-1]	.19	1.00									
W[-1]	.93	.03	1.00								
P				1.00							
YH[-1]				.08	1.00						
HH[-1]						1.00					
Y[-1]						.94	1.00				
P						.96	.83	1.00			
GDP									1.00		
PA									.82	1.00	
TV									.95	.91	1.00

Symbols explained in the List of Variables.

Appendix 9. Correlation matrix for dynamic models.

Model	17, 1961-86			18, 1961-86			
Variable	1	2	3	4	5	6	7
CIRH[-1]	1.00						
YH[-1]	.93	1.00					
P	.60	.64	1.00				
GDP				1.00			
A[-1]				.93	1.00		
PA				.90	.83	1.00	
TV				.83	.75	.86	1.00

Symbols explained in the List of Variables.

Appendix 10. Correlation matrix for single equation models.

Model	21, 1961-86		22, 1961-86	
Variable	1	2	4	5
HH[-1]	1.00			
A	.94	1.00		
GDP			1.00	
PQ			-.14	1.00

Symbols explained in the List of Variables.

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