



The beer market and advertising expenditure

Beer market
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945

Abstract

Purpose – The purpose of this paper is to examine the impacts of advertising expenditure on brands' market shares, utilizing a novel four-week advertising-sales data from the highly competitive oligopolistic Finnish beer market in which price competition among the homogeneous larger-type beer brands is not allowed during the period of the study.

Design/methodology/approach – Competition is modelled using the Lanchester model. The impacts of advertising on market shares are estimated using the impulse-response functions from vector autoregression, and the full information maximum likelihood and advertising elasticities.

Findings – Some new insights into beer market dynamics are obtained. First, the impacts of advertising are not similar across brands. Second, overflows of advertising impacts across brands are detected. Third, the reactions to competitors' advertising attacks are mild.

Originality/value – The paper utilizes four-week brand-level data on the market shares of the leading beer brands in Finland and the brands' advertising expenditure. During the period of the data, price competition is not allowed, which creates a unique opportunity to study the impacts of advertising on the market shares of brands.

Keywords Advertising, Market share, Beer

Paper type Research paper

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1. Introduction

Alcoholic drinks are among the most heavily advertised products. Considerable effort is put into studying advertising impacts, but the effects of advertising on the demand, sales and market shares of alcoholic beverages are not fully understood. This paper examines the impacts of advertising expenditure on beer brand market shares utilizing a novel four-week advertising-sales dataset on the highly competitive oligopolistic Finnish beer market.

Studies on the impacts of advertising expenditure on alcohol demand are broadly based on two types of theories. First, a large body of research on alcohol advertising and sales have originated from demand theory, including the Rotterdam or almost ideal demand systems (Duffy, 1987, 1990, 1995, 2003; Nelson and Moran, 1995; Clements and Johnson, 1983; Selvanathan, 1991). These studies have focused on the effects of advertising on demand among competing alcoholic beverages, such as wine, spirits and beer. The general inference from these studies is that advertising or advertising bans would have only a slight impact on the total demand for alcohol. They suggest, instead, that advertising may merely alter the relative market shares for alcoholic brands[1].



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Second, studies focusing on relative market shares have largely utilised the oligopolistic Cournot-Nash theory of rivalry. The focus has been mainly on the world's largest beer market in the USA and on the rivalry between the leading US breweries and brands, Anheuser-Busch and Miller (Hatten *et al.*, 1978; Kelton and Kelton, 1982; Tremblay, 1985; Wilcox, 2001; Chintagunta and Jain, 1995; Erickson, 1992; Nelson, 2005).

The sample frequency in a dataset plays a significant role when evaluating the impacts of advertising on alcohol demand and market shares. Studies on alcohol demand have mainly used yearly data (Kelton and Kelton, 1982; Erickson, 1992; Hatten *et al.*, 1978; Chintagunta and Jain, 1995; Tremblay, 1985; Tremblay and Tremblay, 1995; Wilcox, 2001; Nelson, 1999; Erickson, 1992)[2]. Even if studies use high-frequency data, they generally have not used information on advertising expenditure at the level of brands or product categories (Larivière *et al.*, 2000; Nijs *et al.*, 2001; Steenkamp *et al.*, 2005). Theoretical works from Bass and Leone (1983) and Leeflang and Reuijl (1985) have indicated that the magnitude of the advertising coefficient should increase with the frequency of data under analysis. Some researchers have argued that even monthly data may be too aggregated. Tellis *et al.* (2000) provided evidence that the impacts of television advertising should be measured in hours. Thus, there is no consensus about the adequate level of aggregation in advertising data.

Another factor, which probably is significant but has not been subject of careful analysis, is the role of price competition when evaluating the impacts of advertising on brand market shares. It is possible that part of the change in sales is due to price discounts. Sometimes advertising campaigns are combined with price promotions. However, advertising may also affect product prices. Advertising may increase competition and lower prices, which in turn results in increased consumption. But advertising may also increase product differentiation, reduce the price elasticities of demand, and shift consumer purchases towards higher-priced brands and beverages (Ambler, 1996). With the capacity to signal product quality, advertising may result in higher equilibrium prices and lower consumption.

Studies have usually excluded the consideration of competitor advertising, and zero-sum competition has often been assumed (Yoo and Mandhachitara, 2003). According to Scherer and Ross (1990), successful brands should have both increased market shares and increased sales. Competitive reactions may, however, change the effectiveness of advertising (Dekimpe and Hanssens, 1995; Yoo and Mandhachitara, 2003). In a zero-sum competition, the advertiser's gain is the competitor's loss. Symbiotic competition, in turn, refers to a situation in which both parties benefit from each other's advertising. In addition, two types of asymmetric rivalry are possible. A favourable situation for a brand arises when a competitor's advertising increases the brand's sales, and the brand's advertising reduces the competitor's sales. In the reverse situation, a brand's advertising increases a competitor's sales while decreasing its own sales. Strong brands usually benefit from rival advertising, while advertising spent on weak brands is wasted. Market leaders, followers and nichers would be expected to differ in their advertising spending behaviours. Typically, the market leader's share of voice, i.e. share of advertising spending, is lower than its market share, because it enjoys a scale advantage and can achieve lower unit costs. A follower, on the contrary, is forced to increase advertising spending in order to stay close to the leader, and so its share of voice might exceed its share of market (Schroer, 1990). Accordingly, the advertising expenditure to sales relationship may vary according to a brand's market position and

its type of rivalry. In markets with many competing products or brands, consumers are influenced by brand advertising. Consumer information-processing and consumer memory may also affect consumer inferences about competitor advertisements. That is, well-known brands have advantages (Kent and Allen, 1994). Brand familiarity may explain why leading brands usually maintain a market share that exceeds their advertising share-of-voice, while less known brands tend to have an advertising share-of-voice greater than their market share (Jones, 1990; Schroer, 1990).

The Lanchester model of combat is probably the most widely used theoretical model analysing the impacts of advertising on sales in industrial organisation theory. The model was introduced by Kimball (1957) and advanced by Little (1979), who pointed out that the model is in fact a generalisation of the Vidale and Wolfe (1957) model. It characterizes the evolution of a brand's market share as a result of both its own advertising as well as rival advertising. Erickson (1985) examined open-loop Nash equilibriums in a multiform decision environment and used competition between beer brands Anheuser-Busch and Miller as an illustration of the model. Erickson (1992) then compared the performance of open loop and closed-loop Nash strategies using the Lanchester model applied to beer markets. The open-loop Nash strategy allows for changes in advertising activities as a result of changes in market share, while the closed-loop strategy regards advertising expenditure as exogenous. Sorger (1979) introduced excess advertising effects into the Lanchester model. Note that each of these studies has involved a duopoly. Empirical applications of the Lanchester model are provided in Erickson (1985), Erickson (1992), Chintagunta and Vilcassim (1992), Chintagunta and Jain (1995), Horsky (1977), Nguyen (1987), and Erickson (1995). Notably, all of these studies have exclusively used yearly data.

Irrespective of country or market, we have lacked brand-level, monthly data with which to evaluate the impact of advertising expenditure on beer brand market shares. This paper addresses the issue by providing new insights into the dynamic effects of advertising expenditure on brand market shares in an oligopolistic setting. The oligopoly examined is the Finnish beer market, which is governed by three countrywide breweries and four leading brands. All the brands are similar, lager beers. Advertising is expected to be an important tool in increasing a brand's market share in this homogeneous lager beer market in which price competition is not allowed and breweries do not offer high-priced premium brands. Accordingly, the Finnish beer market offers us an exceptional opportunity to reveal the persuasive impacts of advertising on beer demand without any price effects. Thus, we are able to estimate some of the pure impact of advertising on beer brand market shares. This makes our data exceptional. The data consists of the advertising expenditure for four lager beer brands and the market shares of these brands at four-week intervals during the period from 1994 to 1999.

The structure of the paper is as follows. Section 2 describes the Finnish beer market. In Section 3, we present a simplified oligopolistic model, which is used to describe competition among the lager beer brands in the Finnish beer market. This section also provides an empirical analysis. Section 4 concludes the study.

2. The Finnish beer market

During the period under study, the Finnish beer market was dominated by two large breweries, the market leader, Hartwall, with a 47 per cent market share, and Sinebrychoff, with a 37 per cent market share. Olvi was a challenger and covered a 14 per cent market share[3]. In addition, there were a few very small niche breweries.

During the period under study, a number of structural changes occurred in the market, and the Finnish beer market became increasingly concentrated. Typically, larger breweries acquired the smaller players, and this led to a consolidation of the market. As a result, two leading breweries accounted for 84.1 per cent of the market in 1999. The third player had a market share of 14.1 per cent, and the rest of the breweries were tiny firms with less than 1 per cent market share. The US brewing industry has a similar structure. It is dominated by three firms, Anheuser-Busch, SAB-Miller and Coors, which together account about 80 per cent of beer shipments. Anheuser-Busch has traditionally been the leading firm in the industry (Nelson, 2005).

Moreover, Finnish breweries have become more international, both by acquiring shares from foreign breweries and by selling their shares to foreign firms. Thus, international beer brands have extended the repertoires of Finnish breweries. Also, note that the total number of brands on the market was 29 in 1999. Four beer brands were selected for the analysis: Koff3, Karhu, Lapin Kulta and Olvi Special. Their market shares are displayed in Table I; Lapin Kulta, Koff3 and Olvi Special are the most popular brands in the Finnish market. Lapin Kulta is the leading brand, governing about one-third of the Finnish beer market. Its market share was rather stable between 1994 and 1999. The second brand, Koff3, lost some of its market share during the study period. Karhu, which is produced by the same brewery as Koff3, was introduced in 1994. Karhu was selected, because it rapidly developed from being a niche brand to occupying second position in market share ranking. We expected the role of advertising expenditure to be visible in the case of this brand. Olvi Special has been regarded as the challenger in the market, acting an alternative to leading brands.

While concentration in the Finnish beer market is high, competing firms tend to watch each other's activities closely. In addition, the products are homogeneous, as basic lager is almost exclusively produced. Light beers or premium beers produced by the domestic breweries have not enjoyed success in the Finnish market. Imported brands are favoured by more affluent consumers, but the market shares of these brands have remained low. In addition, the sale of these special beer products has occurred in restaurants rather than in retail stores.

In Finland, beer consumption is rather evenly distributed across consumer groups. Beer is consumed in all age groups, income groups, and socio-economic groups. In 1995, the consumer groups with the highest consumption expenses for beer were aged 35-44 years and 45-54 years. They represented upper middle class and the highest income bracket. (Household Consumption Expenditure, 1995). The majority of beer purchases are made in retail outlets. Only a small portion of consumption takes place in bars or licensed serving areas (Stakes, 2008). These consumption habits may be explained by the fact that beer prices in bars are much higher than prices in retail outlets.

Brewery	Brands	1994	1995	1996	1997	1998	1999	Mean
Sinebrychoff	Koff3	16.2	14.7	13.8	15.2	14.1	13.5	14.5
	Karhu	2.5	10.0	14.1	16.1	19.4	21.6	14.4
Hartwall	Lapin Kulta	33.2	32.4	35.3	35.3	34.0	32.5	33.8
Olvi	Olvi Special	10.1	9.6	9.4	8.7	7.8	7.5	8.8

Note: Mean refers to the four-week mean value of the market share across the entire sample

Table I.
Market shares of the beer
brands under study,
1994-1999 (yearly
averages)

Advertising is an important tool in creating brand differentiation between these homogenous beer products. Moreover, the absence of price competition further increases the significance of advertising. The prices of alcoholic beverages were dictated by the Finnish alcohol monopoly until 1995, when Finland became a member of EU. Although price regulation was abandoned, breweries and beer retailers did not embark on price competition, as there was an agreement to maintain beer prices above a certain level. This agreement was kept by the beer retailers until 2002, when a foreign grocery retailer refused to be bound by it. During the period 1994-1999, there were virtually no price campaigns in beer marketing, and thus, any shifts in demand were not due to price changes. Non-price competition and a homogeneous product have given the breweries a strong incentive to invest in advertising campaigns. Thus, the period 1994-1999 provides a unique opportunity to examine the effects of advertising expenditure on the market shares of beer brands because of the absence of price competition during that period.

In addition to the regulations concerning beer pricing, the advertising of alcoholic beverages has also been regulated. Up to 1995, advertising was only allowed for alcohol beverages containing less than 2.8 per cent alcohol. This law was actually only nominal, because all breweries were producing the same brands in three degrees of strength (light, or less than 2.8 per cent alcohol; medium, or 2.9-4.7 per cent; and strong, or over 4.7 per cent). Moreover, the law on alcohol advertising restricts the content of beer advertising. Therefore, the breweries have had a very low degree of freedom in designing the creative contents of advertisements, and this has made it difficult for advertisers to create real differences between brands through advertising.

The sales of beer and beer advertising expenditure in Finland vary strongly according to season. This phenomenon is shown in Figure 1, which displays total beer sales and advertising activities by brand. Most beer is sold and most advertising campaigns are implemented during two peak seasons: three summer months and Christmas. There is no clear trend in advertising expenditure. However, a slight increase in the volume of the advertising campaigns at the end of the sample is observed. At that same time, there was a slight increase in the amount of beer sold. The market shares of different beer brands also vary, although less than the amount of beer sold, as shown in Figure 2.

In addition to advertising campaigns, other promotional instruments, such as store displays and the use of shelf space, may have affected beer sales. However, when using aggregate brand-level data from all Finnish grocery stores, it is likely that store displays and the use of shelf space of different brands vary across grocery stores to some extent. This implies that these effects are at least partly cancelled out. Also, the introduction of larger bottles as well as multi-packs (six-pack) starting in 1995 may have caused changes in the sales of some beer brands. However, innovations were usually launched together with large advertising campaigns. Hence, the examination of advertising effects on beer sales may also reflect the impacts of these innovations.

The allocation of advertising budgets across different media is one tool for brand differentiation. The most widely used advertising media in our data were newspapers, television and outdoor advertising. Magazines, radio, and films have also been included in the beer brand media portfolios. Our data reveal that different brands have used different media combinations. This may reflect their objective to seek brand differentiation through unique mixes of media.

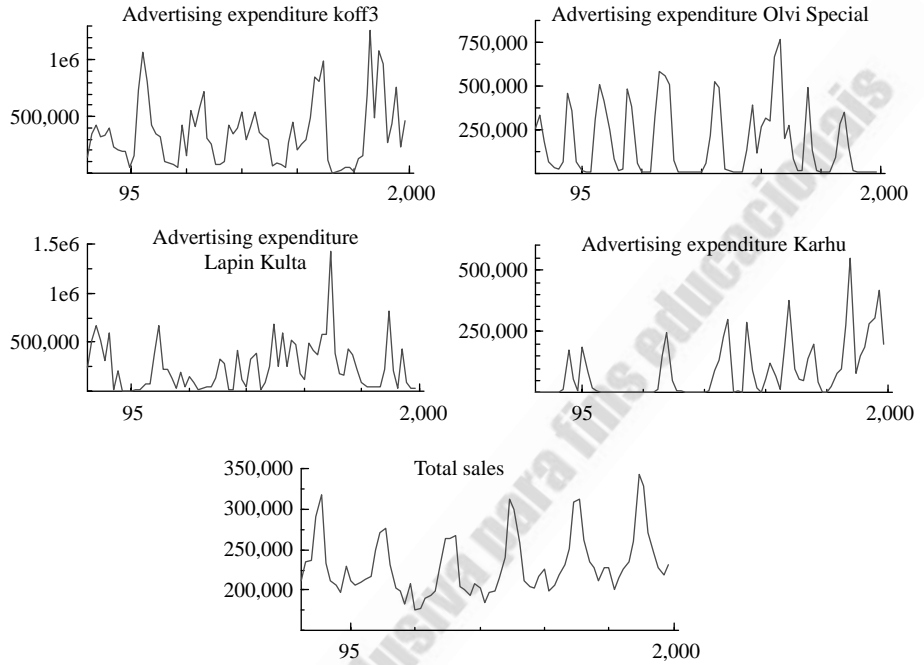


Figure 1.
Advertising expenditure
and total sales

Note: Advertising expenditure is in marks and total sales are thousands of marks, four-week observations (1994-1999)

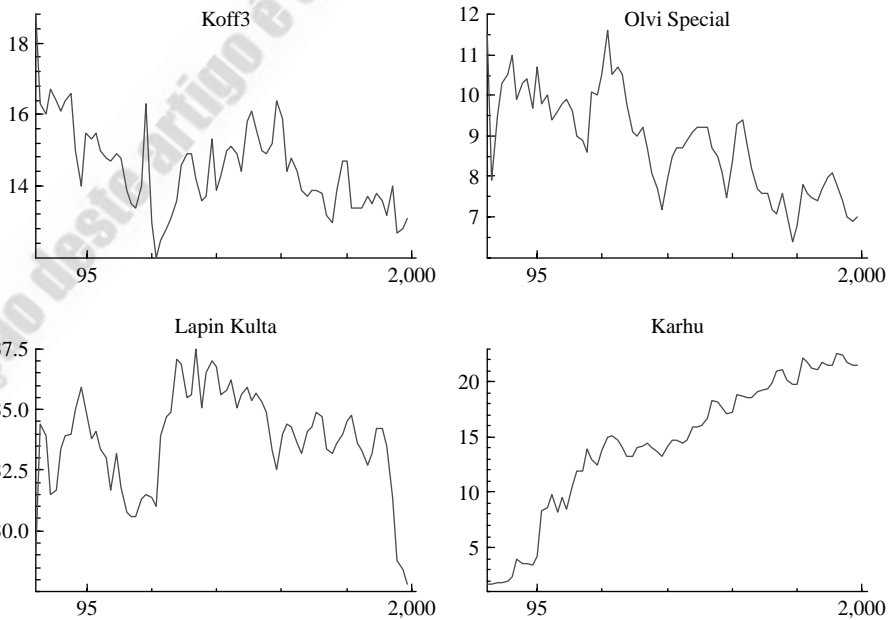


Figure 2.
Market shares of
the beer brands

Table II presents each brand's market shares and advertising expenditure during the years 1994-1999. We may draw the conclusion that no major changes in yearly advertising budgets have taken place, although it seems that the brewery Sinebrychhoff has increased the advertising expenditure for brands Koff3 and Karhu. Nonetheless, when comparing the amount of advertising expenditure and market shares across brands, we may interpret that the change in Karhu's market share, indicated by a notable growth in sales during the period under study, is not exclusively related to its advertising spending. The advertising expenditure of Lapin Kulta remained rather constant by year. The challenger Olvi Special lost its market share steadily during the period under study, although its advertising expenditure remained fairly constant. Thus, it seems that the market leader, Lapin Kulta, spent less on advertising than followers Koff3 and Karhu, supporting the findings of Yoo and Mandhachitara (2003) and Schroer (1990).

3. Advertising and market shares

The Lanchester model is widely used in analysing duopoly markets. The previous empirical applications of the model have used yearly data. The open-loop Nash equilibrium of the Lanchester model has proven to be superior in analysing yearly data. That is, firms may change their advertising budgets based on the yearly performance of their market shares and the advertising campaigns of their rivals. However, we propose that monthly data utilised in this study does not require an open-loop strategy. Firms are not expected to be able to change their advertising plans based on information on current-period sales and competitor advertising campaigns. This is because advertising budgets and strategies are decided on yearly basis. Because of the very high and short period of seasonality in the Finnish beer market, advertising budgets must be designed in advance, without knowing actual market shares during these high seasons. Lags in the execution of advertising campaigns and the very short seasonality of such campaigns make it difficult for firms to react to rival brand-advertising campaigns and market shares in the short term. In addition, previous evidence supports this assumption. Steenkamp *et al.* (2005) provided weekly

Brands		1994	1995	1996	1997	1998	1999
Koff3	Market share	26.1	22.0	19.0	20.2	18.7	18.0
	Advertising	3,833	4,746	4,436	3,845	4,003	7,216
Karhu	Market share	4.0	15.0	19.4	21.4	25.8	28.7
	Advertising	243	294	469	1,161	1,386	2,668
Lapin Kulta	Market share	53.6	48.6	48.6	46.9	45.1	43.3
	Advertising	3,266	2,192	1,773	4,345	5,847	2,154
Olvi Special	Market share	16.3	14.4	13.0	11.5	10.4	10.0
	Advertising	1,806	2,478	2,050	1,930	3,462	897
Total	Market share	100.0	100.0	100.0	100.0	100.0	100.0
	Advertising	9,148	9,710	8,728	11,281	14,698	12,935

Notes: 1000 Finnish marks, FIM, aggregated yearly data; Lapin Kulta includes some variants of the original brand, which have been subject to a rigorous advertising campaign in 1999 (Lapin Kulta Premium 2774 and Lapin Kulta Special 1112 in 1000 FIM); these figures are not included in the advertising expenditure on Lapin Kulta

Table II.
Market shares and
advertising expenditure
of the beer brands
studied, 1994-1999

data on 400 consumer products and showed that the dominant reaction to competitor advertising attacks is no reaction.

Our model differs to some extent from the traditional specification of the Lanchester model. First, we estimated the impacts of all brand advertising expenditure and market shares on each brand's market share; for a closer exposition of the model, see Martin (1993, pp. 139-41). Second, we allowed for richer dynamics than the traditional Lanchester model, which exclusively employs contemporaneous variables. Our specification allowed lagged reactions to changes in advertising campaigns as well as to changes in rival market shares. We specified the advertising and market share response function in a dynamic form, utilizing a general-to-specific modelling strategy. Third, the Lanchester model is widely estimated using the square root rule in order to track the diminishing effects of advertising (Case, 1979; Chintagunta and Jain, 1995; Chintagunta and Vilcassim, 1992; Erickson, 1985, 1992, 1995). However, we did not employ the square root rule. Instead, we estimated the impacts of advertising on market shares by utilizing both the dynamic market share model and impulse-response analysis. These approaches enabled us to track the true shape of relationship between advertising expenditure and market shares.

We assumed that advertising contributes to a long-lived asset, which can be regarded as a goodwill factor that affects future demand. a_t is the stock of goodwill built up at the start of period t . The relationship between advertising (A) and goodwill is:

$$a_t - a_{t-1} = A_t - \gamma a_{t-1} \quad (1)$$

The change in the stock of goodwill from one period to the next is the difference between the amount of current advertising A_t , which is an addition to the stock of goodwill, and the depreciation of the stock of goodwill, which occurs at rate γ .

The inverse demand curve for different beer brand (i) in period t is:

$$p_{it} = f(q_{it} + \theta Q_{-it} a_{it} + \lambda a_{-it}) \quad (2)$$

q_{it} is the output (demand) of brand i , a_{it} is the stock of goodwill enjoyed by brand i in period t . a_{-it} is the combined goodwill of all firms other than firm i at period t . θQ_{-it} is the combined output of all other firms in period t and θ is the product differentiation parameter. λ is an advertising interaction parameter. If $0 < \lambda < 1$, advertising is cooperative, and advertising by any firm shifts the demand curves for all varieties away from the origin. One may expect that a firm's advertising has a greater positive effect on its own demand than on rival demand. If $\lambda = 1$, advertising is perfectly cooperative and advertising by any firm has an equal effect on the demand for all other brands. If $\lambda = 0$, the demand for a brand is not affected by the advertising of other firms. When $\lambda < 0$, a brand's own advertising increases its own demand while shifting the demand for the rival brand towards the origin.

The present-discounted value of a single firm's cash flow is:

$$PDV = \sum_{t=0}^{\infty} (1+r)^{-t} \{ [f(q_{it} + \theta Q_{-it}, a_{it} + \lambda a_{-it}) - c] q_{it} - p_t^A [a_{it} - (1-\gamma)a_{i,t-1}] \} \quad (3)$$

in which p_t^A is the price of advertising. The first-order condition for goods price (p_{it}) is:

$$p_{it} - c = -q_{it} f_1 \quad (4)$$

in which f_I is the partial derivate of f with respect to its first argument. Equation (4) can be written as:

$$\frac{p_{it} - c}{p_{it}} = \frac{s_{it}}{\varepsilon_{Qp}} \quad (5)$$

s_{it} is each brand market share ($s_{it} = q_{it}/Q_{it}$). Finally, ε_{Qp} is the price elasticity of demand in brand i 's market:

$$\varepsilon_{Qp} = -\frac{p_{it}}{Q_{it}} \frac{\partial Q_{it}}{\partial p_{it}} \quad (6)$$

A brand's market power rises when its market share rises and the price elasticity of its demand falls. Advertising is one of the factors that determine ε_{Qp} . The first-order condition for advertising is:

$$\frac{\partial p_{it}}{\partial a_{it}} q_{it} - p_t^A + \frac{1 - \gamma}{1 + r} p_{t+1}^A = 0 \quad (7)$$

Substituting recursively from time t to ∞ results in:

$$p_t^A = \sum_{\tau=0}^{\infty} \left(\frac{1 - \gamma}{1 + r} \right)^{\tau} \frac{\partial p_{i,t+\tau}}{\partial a_{i,t+\tau}} q_{i,t+\tau} \quad (8)$$

The first-order condition for advertising then states that a brand should purchase advertising (a_i) in period t until the price of advertising (p_t^A) in period t equals the present-discounted value of the revenue generated by a marginal increase in goodwill in all future periods. The result can be regarded as a generalisation of the Dorfman and Steiner (1954) condition for a dynamic oligopoly[4].

3.1 The data

The data include observations on advertising and sales of beer brands in Finland from January 1994 to December 1999. Data on the monthly advertising expenditure of the leading beer brands, which was disaggregated by media type, was procured by Suomen Gallup Mainostieto (2000). For each brand, the measure of advertising expenditure was calculated by adding the brand-level advertising expenditure across media. Beer sales observations were obtained from A.C. Nielsen Finland (2000) ScanTrack data. This data set contains four-week observations of the total sales of beer (valued in 1000 FIM) as well as the market shares of the breweries and the respective beer brands. Appendix 1 describes the data in detail.

The ScanTrack data system measures sales of beer in grocery stores larger than 100 m². Beer sold through other channels, such as restaurants and the Finnish alcohol monopoly Alko, are not included in this data. In 1999, retail stores accounted for 67.4 per cent of total beer sales, while the shares of restaurants and Alko were 27.4 and 5.2, respectively, (The Federation of the Brewery and Soft Drinks Industry, 2004). In addition to these recorded sales, about 12 per cent of total sales is unrecorded, which is a significant proportion of total beer consumption. This includes the products imported by travellers and private persons (Stakes, 2008). The data used in this study include beer sold through retail stores, i.e. about two thirds of the total sales of beer

in Finland. This is not expected to cause strong bias in the results, because we believe that consumer preferences towards brands remain constant across outlets.

In order to make the four-week sales data and the monthly advertising expenditure data comparable, we divided the advertising data into four-week periods. This was done by first dividing the monthly advertising expenditure data into daily expenditure and then multiplying the daily expenditure by the number of days (28 days) in each period (four weeks). This process may have changed the nature of the data by smoothing out differences between successive months, but we assume that the modified, four-week data adequately reflect the dynamics of advertising expenditure of these brands.

3.2 Impulse responses

We estimated the sales of each brand in terms of market shares. As mentioned before, the beer brands under scrutiny are Koff3, Karhu, Lapin Kulta and Olvi Special. Our vector autoregression (VAR) specification of the Finnish beer market involved the market shares and marketing expenditure of those four leading Finnish beer brands.

According to the augmented Dickey-Fuller unit root tests, market shares were non-stationary, and advertising expenditure were stationary[5]. A unit root property implies that market shares are evolving in levels. This indicates that if marketing expenses are significantly related to market shares, advertising could have a permanent and long-run impact on market share (Dekimpe and Hanssens, 1999). In our analysis, the market share variables were differenced once, which guaranteed stationarity and robust standard errors[6]. Accordingly, we estimated the impacts of advertising on changes in market shares.

In category demand modelling, VARs usually incorporate many exogenous variables and are regarded as vector autoregressive model with exogenous variables models (Nijs *et al.*, 2001; Steenkamp *et al.*, 2005). However, we examined the impacts of advertising within a homogenous lager beer market and assumed that the impacts of all other factors of importance for beer demand, such as price index, temperature, or income, had an equal impact across brands; this allowed us to use the VAR[7]. Besides, a constant, the VAR included no exogenous variables. The order of lags was determined on the basis of the Akaike's information criterion information criteria, as long as non-autocorrelation was guaranteed. Finally, VAR was estimated utilising two lags ($n = 2$). The residual passed through all the diagnostics tests, except for non-normality for advertising expenditure of Olvi Special, Lapin Kulta, change in market share of Kahu and autoregressive conditional heteroscedasticity (ARCH) for change in market share of Koff3, see Appendix 2. This was not, however, regarded as seriously affecting the robustness of the results, because the residual non-autocorrelation was maintained.

The Choleski factorisation in the impulse-response analysis was utilised to identify structural shocks in the system. Changes in market shares (market share) were applied and advertising expenditure (advertising) were scaled to millions of marks. The order of endogenous variables was as follows: $X = (\text{Koff3 advertising, Koff3 market share, Lapin Kulta advertising, Lapin Kulta market share, Olvi Special advertising, Olvi Special market share, Karhu advertising, Karhu market share})$. Using this ordering in the Choleski decomposition, the relationships between the reduced form residuals and structural shocks were estimated. We arranged the brands according to their advertising expenditure at the beginning of the sample period. Then, the advertising expenditure of Koff3, i.e. the brand with the largest expenditure were

contemporaneously affected only by the shocks to itself, i.e. affected by the shocks to its advertising expenditure and the shocks to its sales. Finally, the brand with the smallest advertising expenditure, Karhu is contemporaneously affected by all the sales and advertising expenditure in the system. In effect, Karhu advertising expenditure or market share had no contemporaneous impact on the market shares of other brands. Other variable orderings in the Choleski decompositions were used, but the results were immune to this problem.

The graphs for impulse responses were estimated utilizing data in which sales were any changes in market shares and advertising expenditure were measured in millions of marks. The impulse-response graphs display the effects of normalized unit structural shocks on advertising expenditure. The standard errors for the impulse responses were estimated utilizing bootstraps with 10,000 draws. Standard errors are the lines below and above the estimated impulse responses (Figures 3-10).

The impulse responses of advertising expenditure of Koff3 to Koff3 market share suggest that the peak in brand Koff3 market shares occurred 12 weeks after an expansion in advertising expenditure. This positive impact on sales lasted about 8 weeks, reaching its highest value, an increase of 0.5 per cent in market sales, in 12 weeks. During the first eight weeks, there was a decrease in sales, which peaked after four weeks. After 16 weeks, the impact was nearly zero. As far as the sales of other brands are concerned, there is limited evidence that advertising expenditure for Koff3 decreased the market share of Lapin Kulta and Karhu, whereas the market share of Olvi Special remained largely immune to shocks from advertising expenditure of Koff3. Overall, the impacts of advertising expenditure on changes in market shares were not permanent. After 20 weeks, the responses to advertising expenditure of Koff3 were nearly zero.

The impacts from the shocks of advertising expenditure of Lapin Kulta suggest that the market share of Lapin Kulta increased for up to two weeks. It also had a positive impact on the sales of Olvi Special, although this impact lasted only about four weeks. The market share of Karhu decreased during the first four weeks, whereas for Koff3, the largest negative impact was detected after eight weeks. In contrast to the other brands, the market share of Olvi Special was largely independent of its advertising expenditure. More likely, an impulse from advertising expenditure of Olvi Special increased the market share of its rival brands Lapin Kulta and Koff3. However, it had a clear negative impact, up to 1 per cent during four weeks, on the sales of Karhu.

The substitution effect between Karhu and Olvi Special was confirmed by further evidence obtained when evaluating the impulses of advertising expenditure of Karhu. An increase in advertising expenditures of Karhu had a negative impact on the market share of Olvi Special, which could last up to 16 weeks. The positive impact on the market share of Karhu lasted about four weeks. Thereafter, there was a change of the same magnitude in market share. The changes in market shares were relatively strong. First, an increase of one million marks in advertising expenditure could cause a temporary 2 per cent rise in the market share of the brand, which was followed by a decrease of an equal amount in its market share. The impulse response of advertising expenditure of Karhu also indicated a strong and negative impact on the market share of Lapin Kulta. The negative impact reached its maximum after eight weeks and decreased steadily during the next 24 weeks.

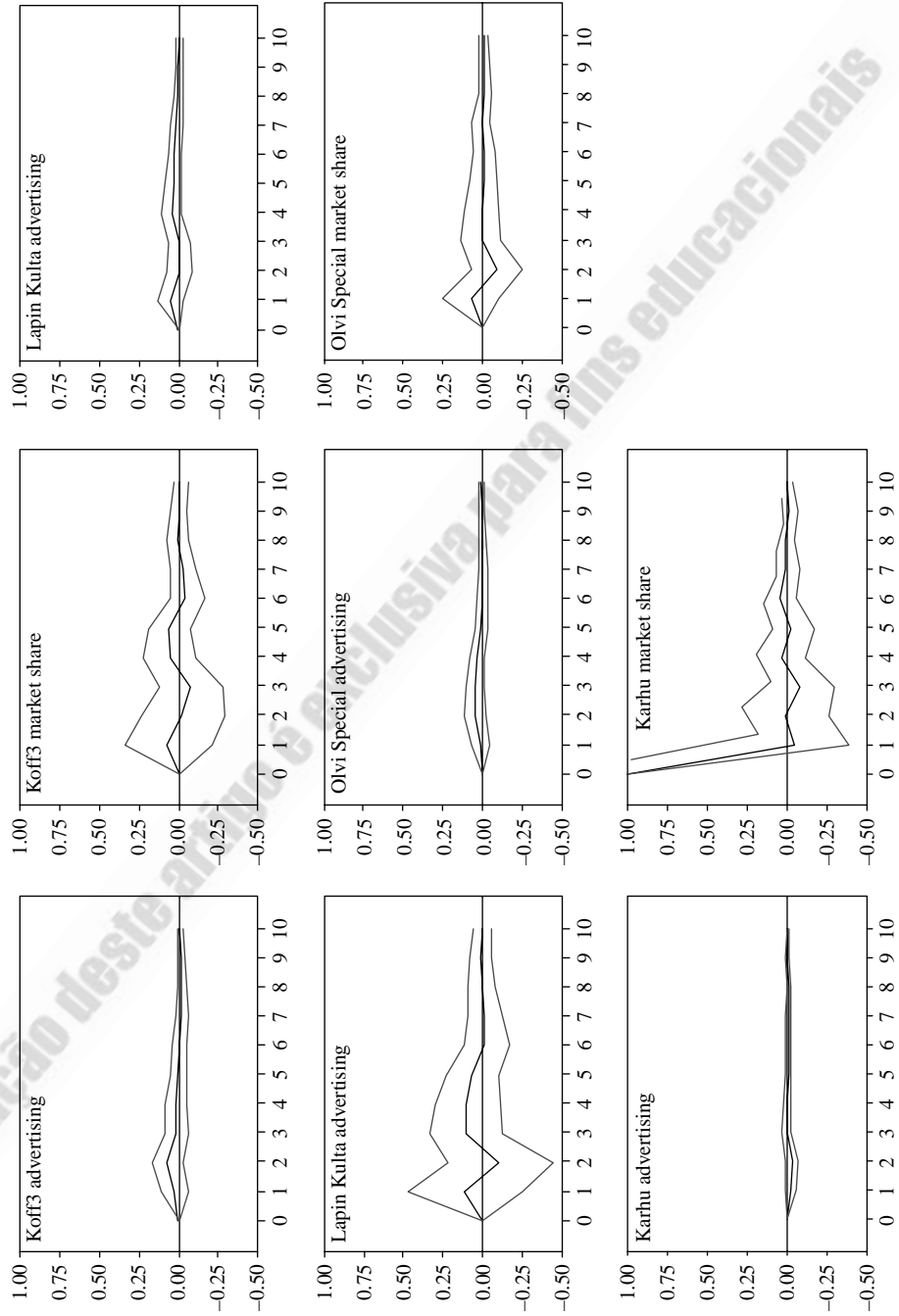


Figure 3.
Effects of a shock to Karhu
market share

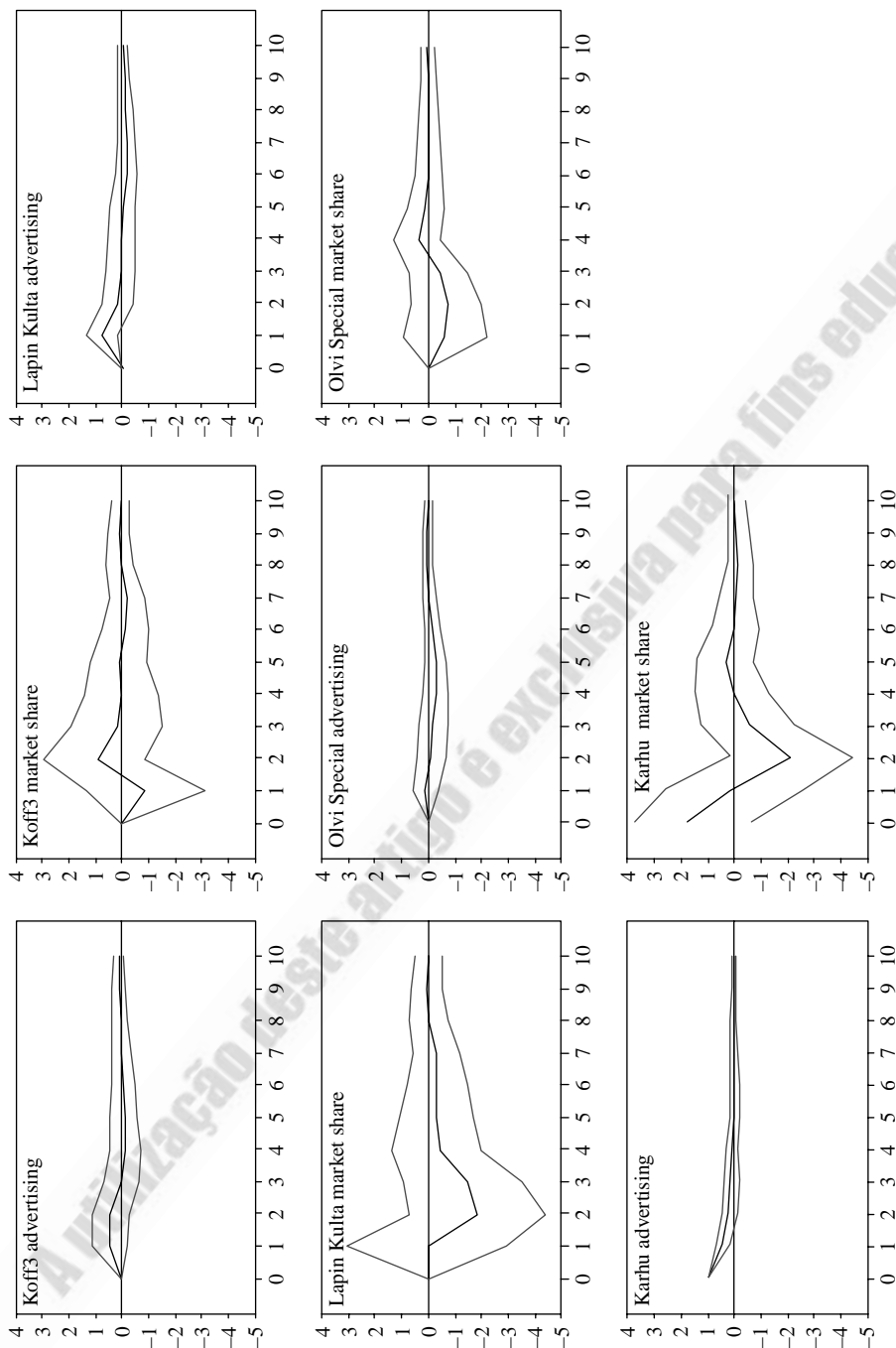


Figure 4. Effects of a shock to Karhu advertising expenditure

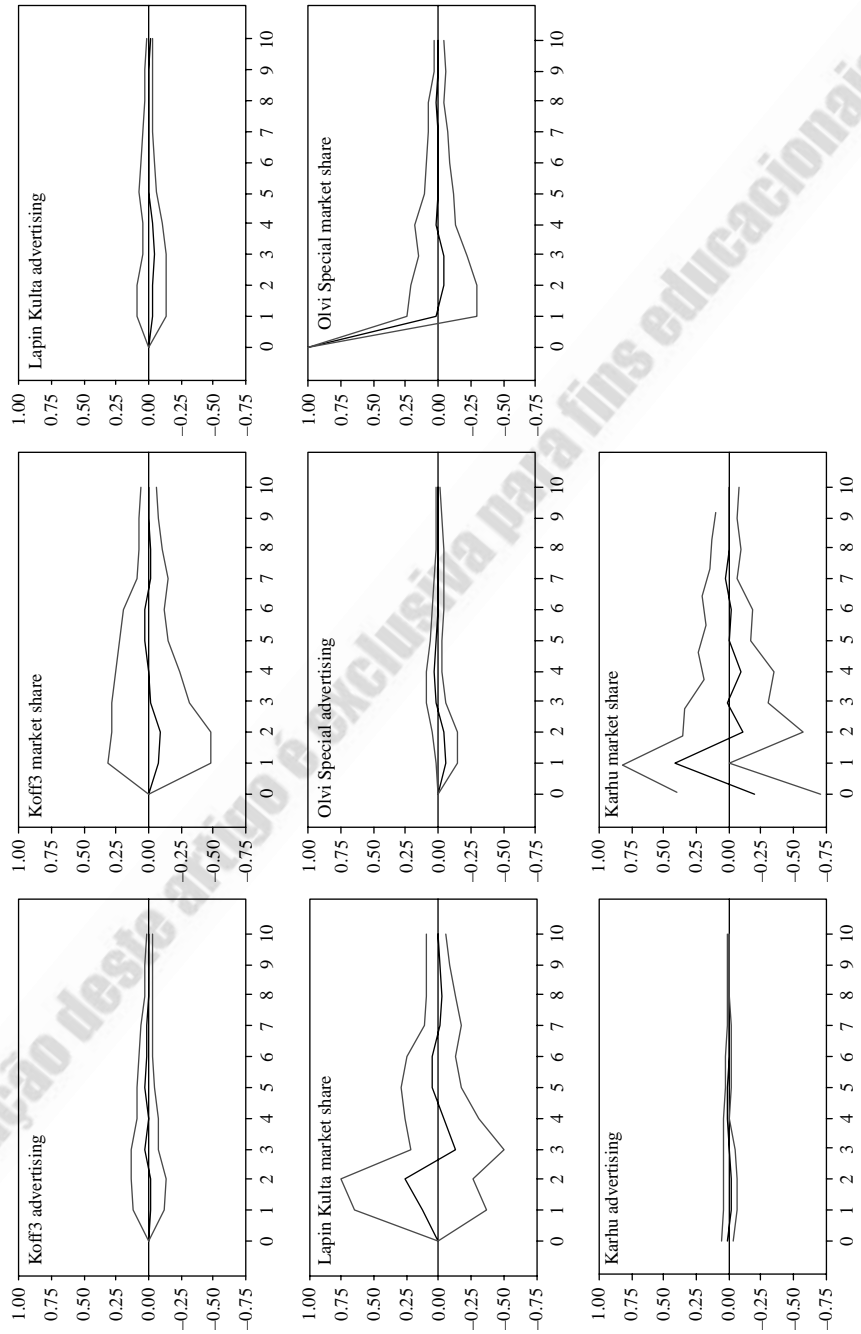


Figure 5.
Effects of a shock to Olvi
Special market share

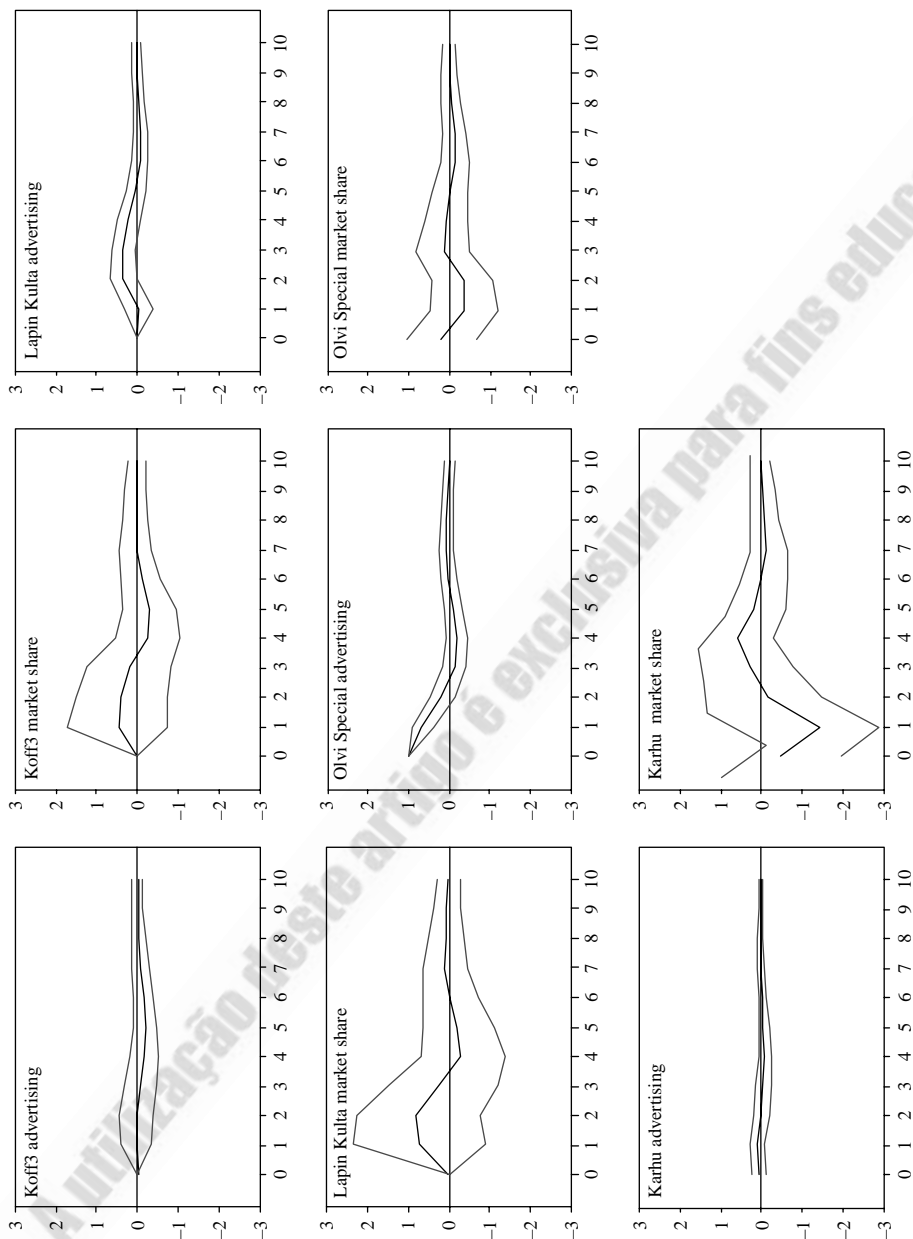


Figure 6.
Effects of a shock to Olvi
Special advertising
expenditure

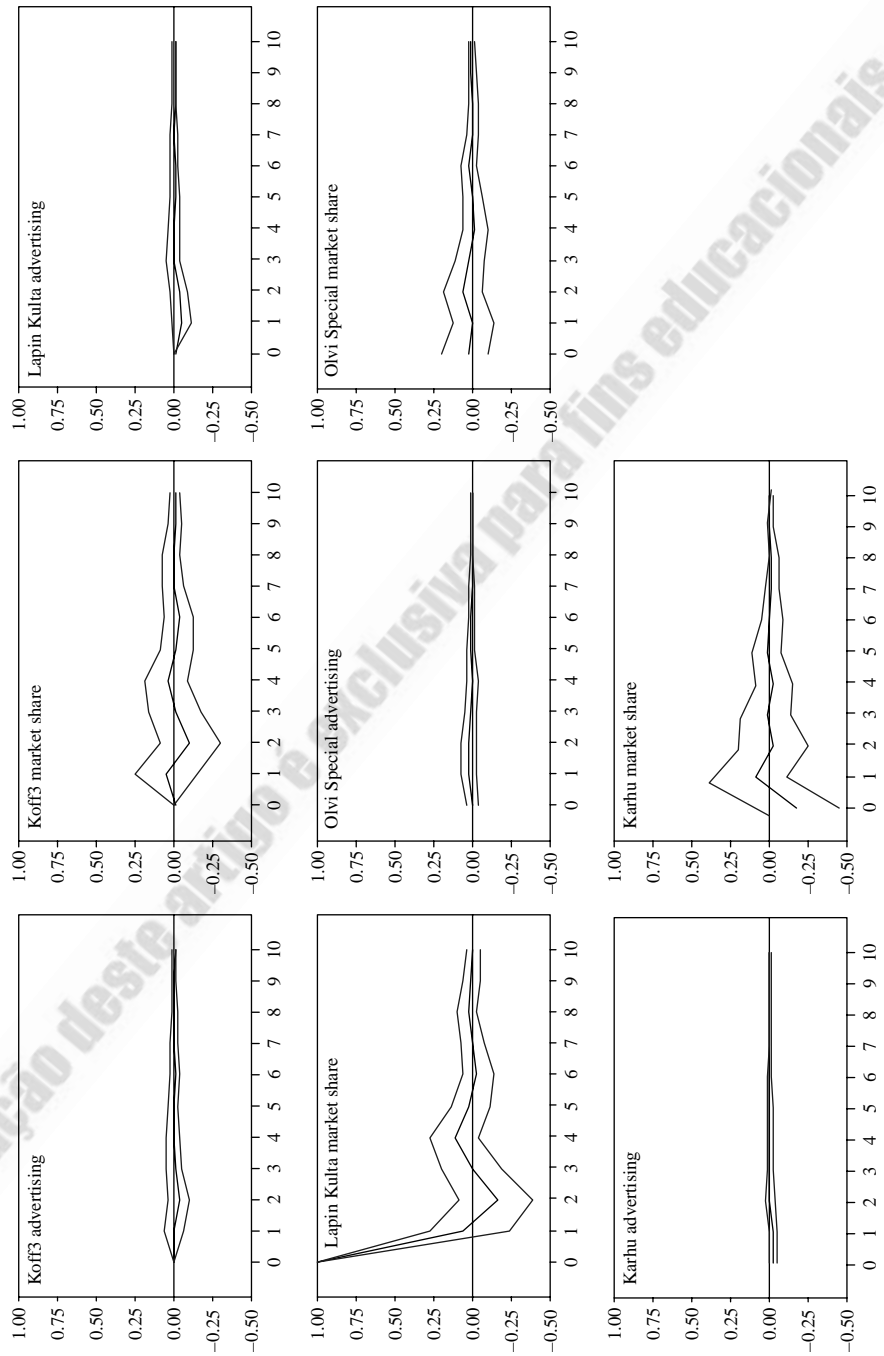


Figure 7.
Effects of a shock to Lapin
Kulta market share

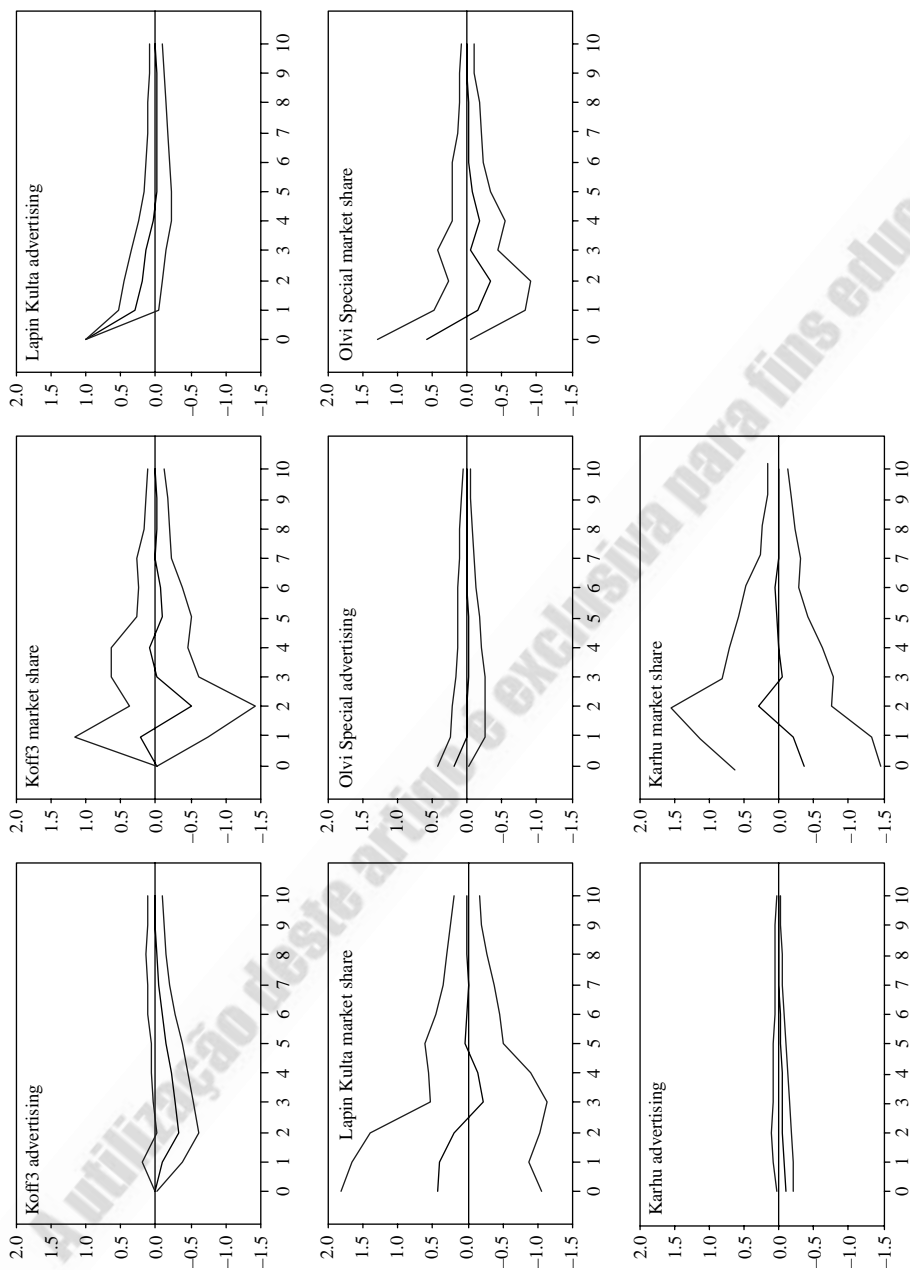


Figure 8. Effects of a shock to Lapin Kulta advertising expenditure

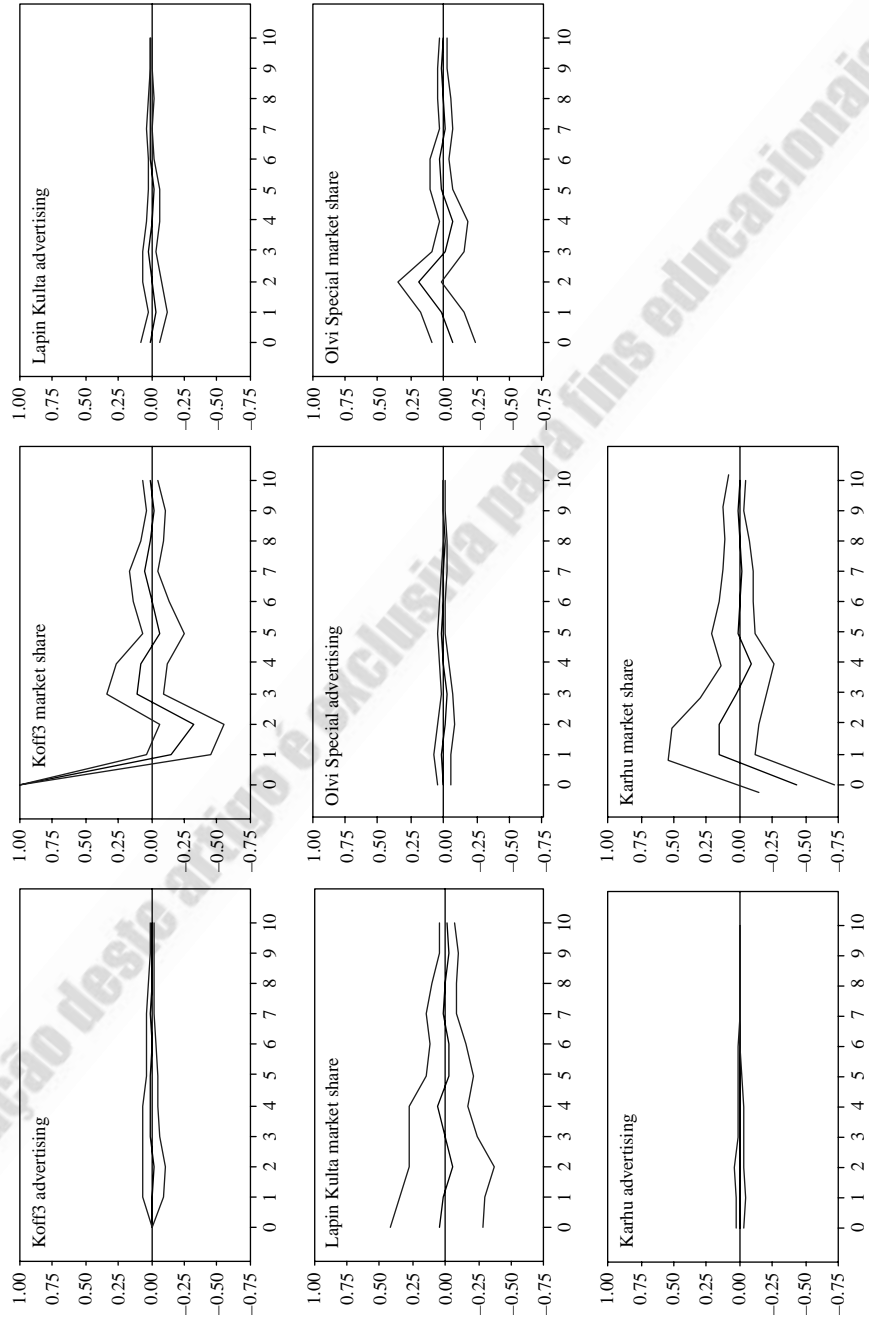


Figure 9.
Effects of shock to Koff3
market share

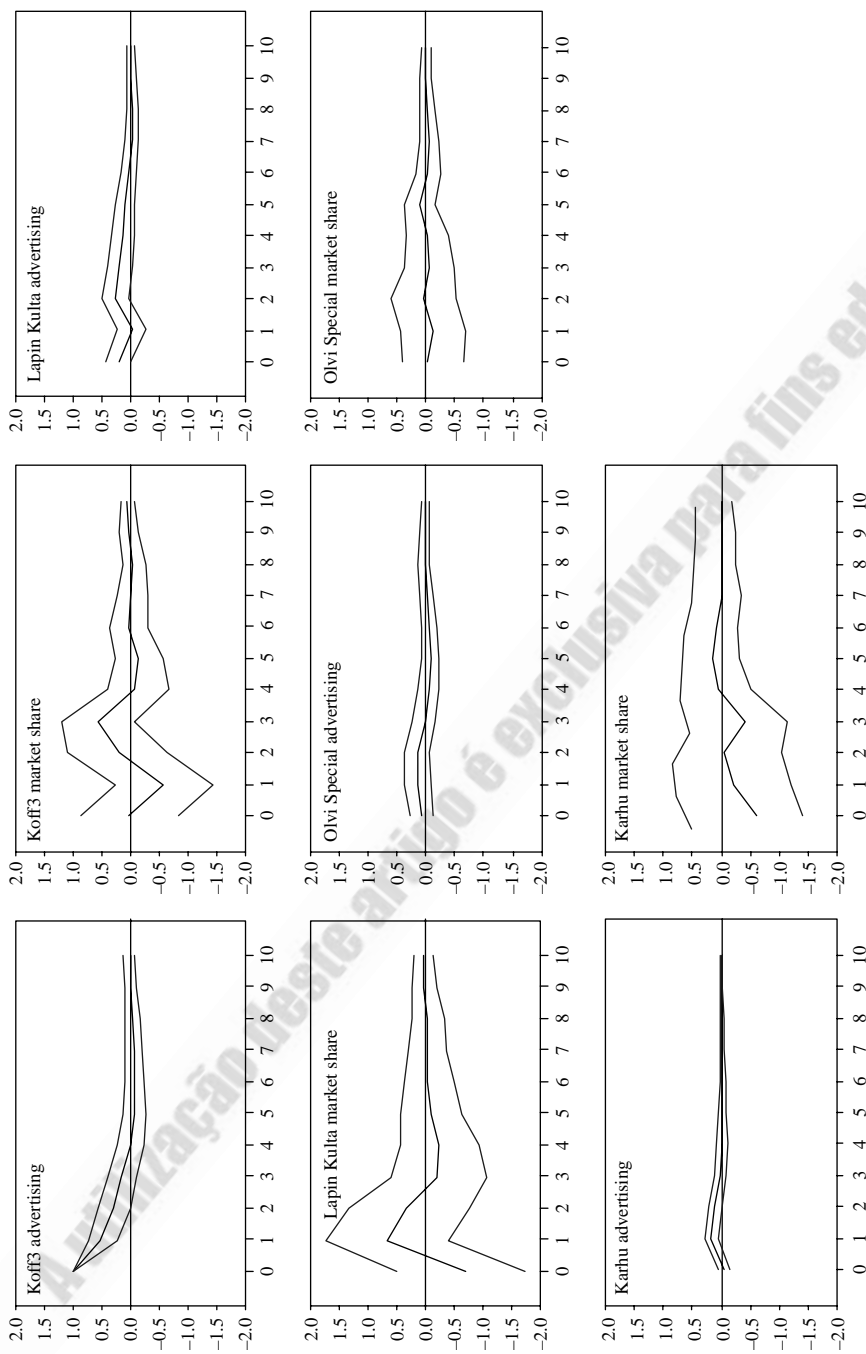


Figure 10. Effects of a shock to Koff3 advertising expenditure

As far as the responses of advertising expenditure are concerned, the impulse responses do not provide strong evidence that brand advertising expenditure were the result of changes in rival brand advertising expenditure. This supports our simplified modelling strategy that assumed advertising expenditure can be regarded as exogenous. It is also consistent with evidence provided in category studies (Steenkamp *et al.*, 2005). We might state that the advertising expenditure of leading brand Lapin Kultra systematically indicate some reaction to the marketing activities of other brands.

Regarding the impulse responses to changes in market shares, some evidence suggests that Lapin Kultra acquired market share from Karhu, Olvi Special from Koff3, and Koff3 from Karhu. Thus, the impacts do not appear to have been symmetrical. In addition, there was some evidence of a simultaneous increase in major brand market shares. An increase in the market share of Olvi Special temporarily increased the market share of Lapin Kultra as well. Similarly, an increase in the market share of Karhu slightly and temporarily increased the market shares of all the other brands, i.e. Koff3, Lapin Kultra and Olvi Special.

Evidence regarding the impacts of advertising expenditure on market shares is presented in Table III. First, there is evidence that the accumulated impact of advertising expenditure of Koff3 on the market shares of all brands is negative and varies from (Koff3 -0.05 to -1.119 Karhu). The accumulated impulse responses to

Koff3 advertising expenditure	Koff3 market share	Lapin Kultra market share	Olvi Special market share	Karhu market share
0	0.03116	-0.70738	-0.03354	-0.61724
1	-0.54918	-0.05186	-0.15889	-0.83458
3	0.18777	0.08047	-0.11401	-1.30205
8	-0.10298	-0.37991	-0.17462	-1.06978
10	-0.05010	-0.33472	-0.18855	-1.11903
<i>Lapin Kultra advertising expenditure</i>				
0	0.00000	0.43364	0.55960	-0.35469
1	0.22412	0.85010	0.41505	-0.56539
3	-0.29166	0.83131	0.06470	-0.32491
8	-0.32893	0.73740	-0.23823	-0.25033
10	-0.33083	0.74997	-0.23658	-0.25186
<i>Olvi Special advertising expenditure</i>				
0	0.0000	0.0000	0.21425	-0.46837
1	0.44991	0.71177	-0.11368	-1.85507
3	1.06625	1.74094	-0.31471	-1.75175
8	0.52931	1.38667	-0.48866	-1.16546
10	0.57007	1.44503	-0.47663	-1.14071
<i>Karhu advertising expenditure</i>				
0	0.0000	0.0000	0.0000	1.64704
1	-0.81258	-0.04163	-0.59635	1.77156
3	0.23290	-3.18849	-1.73450	-0.80991
8	0.14708	-4.53976	-1.25625	-0.71035
10	0.29272	-4.47601	-1.21668	-0.85029

Table III.
Accumulated impulse responses of sales to innovations in advertising expenditure

Notes: Period refers to number of weeks; impulses from advertising expenditure are scaled as one structural change (million of marks); market shares refer to the percentage change in market share (percentage); advertising expenditure are millions of marks

advertising expenditure of Lapin Kulta had a positive and permanent impact on the brand's own market share. In addition, there is evidence that advertising could have a positive impact on rival brand market shares. An impulse response from Karhu advertising expenditure would increase the market share of Koff3, whereas impulse responses from advertising expenditure of Olvi Special would increase the market shares of Koff3 and Lapin Kulta.

In sum, the results suggest that the total impact of advertising expenditure on market shares is brand-dependent. Advertising expenditure may have either positive or negative impact on brand sales, and the impacts between brands seem to be asymmetrical. Also some spillover effects across brands were detected, and in some cases, a rival brand succeeded in reaping the benefits from a brand's advertising expenditure. The evidence on spillover effects is not exceptional. Nguyen (1987) provided evidence on spillover effects for advertising across brands in a multi-brand cigarette industry.

3.3 FIML system estimation

Next, we estimated parsimonious equations to determine each brand's market share. We did not model firm advertising expenditure as reactions to the advertising expenditure or sales of other firms. This assumption was supported by VAR, which utilised monthly data as well as evidence from category-level studies (Steenkamp *et al.*, 2005). Thus, only market share was treated as an endogenous variable. First, full information maximum likelihood (FIML) was estimated in its unrestricted form, with four lags on each variable. Using a general-to-specific modelling strategy, the final parsimonious model was estimated. The over-identifying restrictions did not reject, which validates the reduction of the model. The diagnostics were not completely satisfactory, however, since the system suffered from some non-normality due to strong seasonal variation in advertising expenditure. No extra dummies were included. Numbers in parentheses are *t*-statistics:

$$\Delta MS(\text{Koff3}) = -0.06197 - 0.3125 \Delta MS(\text{Koff3})_{t-2} + \varepsilon_t, \quad \sigma = 0.77975 \quad (9)$$

(0.663) (2.94)

$$\Delta MS(\text{Olvi special}) = -0.0083 - 0.2145 \Delta MS(\text{Olvi special})_{t-4} + 0.1836 \Delta MS(\text{Koff3})_{t-2} +$$

(0.105) (2.87) (2.79)

$$+ 0.1615 \Delta MS(\text{Karhu})_{t-4} - 0.376 - AD(\text{LapinKulta})_{t-1} + \varepsilon_t, \quad \sigma = 0.450639 \quad (10)$$

(2.75) (1.73)

$$\Delta MS(\text{LapinKulta}) = 0.02609 - 0.895 - AD(\text{Koff3})_{t-4} + \varepsilon_t, \quad \sigma = 0.993722 \quad (11)$$

(1.41) (2.22)

$$\Delta MS(\text{Karhu}) = 0.0479 + 1.34 AD(\text{Olvi special})_{t-3} + \varepsilon_t, \quad \sigma = 0.886326 \quad (12)$$

(0.357) (2.80)

Diagnostics

Likelihood ratio for over-identifying restrictions $\chi^2(17) = 9.7346$ (0.9144), vector Portmanteau (8) = 133.57, vector EGE-AR 1-5; $F(80,179) = 0.91858$ (0.6624), vector normality test; $\chi^2(8) = 44.649$ (0.0000), vector hetero test; $F(120, 371) = 1.0327$ (0.4043).

The FIML system suggests that the change in the market share of Koff3 is mainly an evolving one based on the second order autoregressive process, AR(2). Accordingly, Koff3 was largely immune to other brand market shares as well as the advertising of other brands. Olvi Special was dependent on the dynamics of the other brands and the advertising expenditure of Lapin Kulta. Accordingly, increases in the market shares of Koff3 and Karhu increased the market share of Olvi Special, which suggests that these beer brands may complement consumer tastes. The negative impact of advertising expenditure of Lapin Kulta on Olvi Special, in turn, suggests that Lapin Kulta and Olvi Special may be substitutes. An increase in advertising expenditure of Lapin Kulta increased the utility of brand Lapin Kulta, which decreased the demand for its substitute, Olvi Special. However, Lapin Kulta turned out to be a substitute for Koff3, since advertising expenditure for Koff3 decreased the market share of Lapin Kulta. In addition, some evidence for a positive substitution effect was obtained based on the impact of advertising expenditure of Olvi Special on the market share of Karhu. That is, one million marks spent on advertising Olvi Special might in fact increase the market share of its rival, Karhu, by 1.3 per cent or about 0.3 million marks.

3.4 Long-run advertising elasticities

Finally, we estimated the long-run static elasticities for both market shares and sales, utilising FIML and four lags on each of the variables. These estimations were performed mainly to check the robustness of our results with respect to previous studies on advertising elasticity; see Appendices 3 and 4 for details. The elasticities were fairly low, suggesting that advertising expenditure had only a mild impact on sales. The mean market share elasticity was about 0.023, and the mean sales elasticity was about 0.040. These figures are in line with the elasticities of aggregate beer demand reported in other studies[8].

The signs of the elasticities varied among the brands and in many cases contradicted the assumption of a positive advertising elasticity with respect to a brand's own advertising and a negative elasticity with respect to a rival brand's advertising. For example, for Lapin Kulta the elasticity of sales was negative with respect to the brand's own advertising expenditure. For Olvi Special, the elasticity of sales with respect to Koff3 and Karhu advertising was positive, suggesting some spillover effects of advertising on the sales of rival brands. The results should, however, be interpreted with great care, since none of the long-run elasticities were statistically significant.

In sum, our paper suggests that advertising may not have a great impact on the beer market, not even at the brand level. These findings to some extent contrast studies utilizing brand-level yearly data. Chintagunta and Jain (1995) and Erickson (1992) utilised the Lanchester model and found significant evidence for the impacts of advertising expenditure on market shares between Anheuser-Bush and Miller. Additional positive evidence regarding the impacts of advertising on market shares is available based on other markets; see Erickson (1992) for an analysis of Coca-Cola and Pepsi and Chintagunta and Jain (1995) for an analysis of pharmaceutical products, and detergents, and between Pepsi and Coca-Cola. Erickson (1995) provided significant

evidence on the impacts of advertising among the three largest ready-to-eat cereals in the US market. Part of the difference in our results may stem from the monthly data used in this study in contrast with the yearly data used in other studies. Some difference may also stem from the fact that our model employs a four-brand system, while the earlier studies examined the impacts of advertising utilising the Lanchester duopoly model, although the evidence from Erickson (1995) is still outstanding.

Our results have some managerial implications regarding the optimal level of advertising. As far as the conditions outlined by Dorfman and Steiner (1954) and the level of optimal advertising expenditure are concerned, the following tentative results can be drawn from our estimates[9]. Based on Selvanathan's (1991) estimate for the price elasticity of beer in Finland (-0.5) and our mean value for advertising elasticities across brands (0.040), the optimal advertising-to-sales ratio (0.040/0.5) would be about 0.08[10]. Regarding brand-level evidence, the optimal advertising to sales ratios for Koff3 would be 0.20 (0.10/0.5); for Karhu, 0.001 (0.0005/0.5); and for Olvi Special, 0.08 (0.04/0.5). For Lapin Kulta, the ratio becomes meaningless, since the brand's advertising elasticity with respect to its own advertising expenditure was negative. The actual mean figures for the advertising-to-sales ratio during the sample period were as follows: Koff3, 0.011; Karhu, 0.002; Olvi Special, 0.008; Lapin Kulta, 0.003. Accordingly, the Dorfman-Steiner condition suggests that:

- brand Koff3 should increase its advertising expenditure;
- Karhu is rather close to optimum; and
- Olvi Special spends too much.

However, all figures must be interpreted carefully, because the advertising elasticities were insignificant.

4. Conclusions

The research on the impacts of advertising expenditure on beer brand market shares has mainly utilised brand-level data on yearly sales and advertising expenditure. This paper utilised four-week brand-level data on the market shares of the leading beer brands in Finland and corresponding brand advertising expenditure. Previous studies have indicated that yearly data requires an open-loop strategy, whereas statistical evidence on category-level weekly data suggests that brands experience non-reactivity to competitor advertising campaigns, which favours a closed-loop strategy (Steenkamp *et al.*, 2005). Because we used four-week data, we chose not to endogenise advertising expenses, and so a closed-loop Lanchester model was applied.

We expected to detect the pure effects of advertising on brand market shares, since price competition was outlawed in the Finnish beer market during the period under study. As such, the Finnish beer market was described as an oligopolistic market in which each firm sells at the prevailing prices and uses advertising campaigns irrespective of rival behaviour. We evaluated the dynamics of each brand's market share resulting from its as well as competitors advertising expenditure and market shares. Dynamic impulse-response functions for advertising expenses and simultaneous parsimonious FIML for the Finnish beer market were estimated.

The results were partly in contrast with extant brand-level studies utilising yearly data, such as Chintagunta and Jain (1995) and Erickson (1992, 1995). Overall, the elasticity of market share with respect to advertising expenditure was low and statistically insignificant. Nevertheless, some new insights were revealed, which can only be detected if

brand-level data is utilised. First, the impact of advertising on market shares was not symmetrical across brands. In some cases, a brand's advertising expenditure decreased its own market share. There was also evidence of positive spillover effects from a brand's advertising expenditure on rival brand market shares. The results show that strong brands, such as Koff3, benefited from the advertising spending of weaker brands, such as Olvi. Meanwhile, Koff3 had no positive impact on Olvi's market share. These findings support the existence of asymmetric rivalry (Yoo and Mandhachitara, 2003). In general, brand information from advertising was not always associated with the brand advertised. Brand familiarity is one explanation for this. Accordingly, strong and well-known brands tend to be able to keep their market share with a proportional share of advertising, while a greater share of advertising voice is required for weaker brands to maintain market share (Kent and Allen, 1994; Jones, 1990; Schroer, 1990).

Our results suggest that rivalry in the market examined is rather complicated. In contrast with previous studies utilizing yearly brand-level data, we were able to provide only modest evidence that selected brands can generate higher market shares through advertising. These differences may stem in part from differences in sample frequency. Another explanation for the contradictory results may be differences in price competition. It is possible that the studies providing evidence on the positive impacts of advertising on sales or market shares have used data in which advertising campaigns were conflated with price promotion campaigns. Our results suggest that when no price competition is allowed, the impacts of advertising campaigns become less obvious. In any case, the results indicate that great care should be taken in planning and implementing advertising campaigns. The possibility for positive spillover effects across some brand market shares shows that advertising expenditure can in fact generate higher market shares for rival brands. What is more, occasionally a brand's own advertising may lead to a decrease in its market share. This may stem from reverse causality as well as attempts to resuscitate failing brands through advertising campaigns.

This study has focused on examining the impacts of advertising spending on the market shares of beer brands, and some interesting features in this relationship were detected. Further studies could examine in detail the contextual factors that mediate this relationship. Advertising spending alone does not always reveal the effectiveness of an advertisement; rather, the effects of advertising differ over various contexts, such as medium, message, novelty, and positioning (Tellis, 2004). The observation of asymmetric rivalry leads us to focus attention on advertising content whereby brand differences are created (Tellis, 1988). The effects of advertising on sales may vary according to the type of media used. Wilcox and Gangadharbatla (2006) found that radio and cable advertising had a positive relationship with beer consumption, whereas outdoor advertising was negatively associated with beer consumption. Our data allow for the disaggregating of advertising expenditure of brands across different media. Hence, future studies could focus on examining if the type of media has any role in mediating the effects of advertising spending. The effects of other contingent factors also require further investigation.

Notes

1. For an extensive survey of studies on the impacts of advertising on alcohol sales, see Nelson (2001).

2. Also the existing alcohol and beer demand studies have utilised either quarterly or yearly data. For studies using quarterly data, see Saffer (1997), Duffy (1987, 1990, 1995, 2003), Nelson (1999), Coulson *et al.* (2001) and Franke and Wilcox (1987). Yearly data evidence is provided in Wilcox and Gangadharbatla (2006), Nelson and Moran (1995), Tegene (1990), Clements and Johnson (1983), Johnson *et al.* (1992), Selvanathan (1989), Lee and Tremblay (1992) and Gius (1996).
3. These market share figures are from 1999.
4. The original Dorfman and Steiner (1954) condition states that the optimal level of advertising is obtained when the advertising to sales ratio $(p^A A)/(pQ)$ equals the ratio of advertising elasticity to price elasticity $\varepsilon_{QA}/\varepsilon_{Qp} : [(p^A A)/(pQ)] = (\varepsilon_{QA}/\varepsilon_{Qp})$.
5. Tests are available upon request.
6. This also allows us to interpret the impacts of advertising expenditures (in millions of marks) in terms of market shares (i.e. sales in thousands of marks). The mean value for total beer sales during the estimation period was 230.090 thousand Finnish marks (1 euro = 5.9730 marks) at current prices.
7. For those factors, see Nelson and Moran (1995), Franses (1991), Nelson and Young (2001) and Wilcox and Gangadharbatla (2006).
8. The comparison of elasticities between studies is not straightforward. The use of different models of demand and various estimation methods may influence the results. Irrespective of the model specification, the following advertising elasticities of aggregate beer demand have been reported. For studies utilising quarterly data, see Duffy's (1995) 0.31, Duffy's (1990) 0.01, Nelson's (1999) 0.01, Coulson *et al.*'s (2001) 0.03 and Duffy's (2003) interval of -0.008 and 0.002 . For studies using yearly data, we see Duffy's (1995) 0.06, Blake and Nied's (1997) 0.10 and Nelson and Moran's (1995) 0.01. Note that Leone (1995) and Bass and Leone (1983) indicate that the magnitude of the advertising coefficient increases with the length of the data interval employed in the analysis.
9. The Dorfman and Steiner (1954) condition states that the ratio of advertising expenditures to sales should equal the ratio of advertising elasticity of demand (i.e. sales) to the absolute value of the price elasticity of demand.
10. This price elasticity for beer is within the range reported in other studies, see Larivière *et al.* (2000).

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Appendix 1

Variables used in the estimations.

The data covered the period from January 1994 to December 1999, four-week periods:

Advertising Koff3	Advertising expenditure of Koff3, value in millions of marks
Advertising Karhu	Advertising expenditure of Karhu, value in millions of marks
Advertising Lapin Kultra	Advertising expenditure of Lapin Kultra, value in millions of marks
Advertising Olvi Special	Advertising expenditure of Olvi Special, value in millions of marks
$\Delta MS(Koff3)$	Change in market share percent of Koff3
$\Delta MS(Karhu)$	Change in market share percent of Karhu
$\Delta MS(Lapin Kultra)$	Change in market share percent of Lapin Kultra
$\Delta MS(Olvi Special)$	Change in market share percent of Olvi Special

$\Delta ms(Koff3)$	Change in log of market share percent of Koff3
$\Delta ms(Karhu)$	Change in log of market share percent of Karhu
$\Delta ms(Lapin\ Kulta)$	Change in log of market share percent of Lapin Kulta
$\Delta ms(Olvi\ Special)$	Change in log of market share percent of Olvi Special
$\Delta ad(Koff3)$	Change in log of Koff3 advertising expenditure, value in marks
$\Delta ad(Olvi\ Special)$	Change in log of Olvi Special advertising expenditure, value in marks
$\Delta ad(Lapin\ Kulta)$	Change in log of Lapin Kulta advertising expenditure, value in marks
$\Delta ad(Karhu)$	Change in log of Lapin Kulta advertising expenditure, value in marks
$\Delta s(Koff3)$	Change in log of sales of Koff3, value in thousands of marks
$\Delta s(Karhu)$	Change in log of sales of Karhu, value in thousands of marks
$\Delta s(Lapin\ Kulta)$	Change in log of sales of Lapin Kulta, value in thousands of marks
$\Delta s(Olvi\ Special)$	Change in log of sales of Olvi Special, value in thousands of marks

Appendix 2

	JB (2)	LM(2)	ARCH(2)
Advertising Koff3	5.0559 (0.0798)	3.7049 (0.1569)	6.6240 (0.0364)
Market share Koff3	7.4071 (0.0246)	4.5324 (0.1037)	10.4379 (0.0054)
Advertising Lapin Kulta	9.4962 (0.0087)	2.4202 (0.2982)	1.0156 (0.6018)
Market share Lapin Kulta	0.6782 (0.7124)	1.4326 (0.4886)	2.0802 (0.3534)
Advertising Olvi Special	13.0427 (0.0015)	5.7946 (0.0552)	3.5368 (0.1706)
Market share Olvi Special	1.1221 (0.5706)	5.1052 (0.0779)	1.2040 (0.5477)
Advertising Karhu	4.6369 (0.0984)	0.6450 (0.7243)	2.5334 (0.2818)
Market share Karhu	21.5293 (0.0000)	5.2580 (0.0721)	0.0104 (0.9948)

Notes: Market share refers to change each brand's in market share percent, advertising refers to each brand's advertising expenditures in millions of marks; JB refers to Jarque-Bera test for normality; LM to Lagrange multiplier test for residual autocorrelation and ARCH to the test of Autoregressive Conditional Heteroscedasticity; numbers in parenthesis denotes statistical significance

Table AI.
Tests for residual
diagnostics

Appendix 3

FIML estimates for static, long-run elasticities for market shares: log of market shares, log of advertising expenditure. Numbers in parenthesis are standard errors:

$$\Delta \text{ms}(\text{Karhu}) = 0.020658 - 0.15082 \Delta \text{ad}(\text{Koff3}) - 0.0012061 \Delta \text{ad}(\text{OlviSpecial}) \quad (\text{A1})$$

(0.0375) (0.17439) (0.13570)

$$- 0.021793 \Delta \text{ad}(\text{Lapin Kulta}) + 0.041696 \Delta \text{ad}(\text{Karhu}) + \varepsilon_t$$

(0.26297) (0.086969)

$$\Delta \text{ms}(\text{Olvi special}) = - 0.004825 + 0.00058660 \Delta \text{ad}(\text{Koff3}) \quad (\text{A2})$$

(0.0064457) (0.029954)

$$- 0.0010345 \Delta \text{ad}(\text{Lapin Kulta})$$

(0.045170)

$$+ 0.009430 \Delta \text{ad}(\text{Karhu}) + 0.002945 \Delta \text{ad}(\text{Olvi special}) + \varepsilon_t$$

(0.014939) (0.023322)

$$\Delta \text{ms}(\text{Koff3}) = - 0.00068122 + 0.0084314 \Delta \text{ad}(\text{Koff3}) - 0.010287 \Delta \text{ad}(\text{Lapin Kulta}) \quad (\text{A3})$$

(0.0062404) (0.02900) (0.043731)

$$- 0.010816 \Delta \text{ad}(\text{Koff3}) + 0.018437 \Delta \text{ad}(\text{Olvispecial}) + \varepsilon_t$$

(0.014463) (0.022579)

$$\Delta \text{ms}(\text{Lapin Kulta}) = - 0.0019923 + 0.014613 \Delta \text{ad}(\text{Koff3}) \quad (\text{A4})$$

(0.0077486) (0.036009)

$$- 0.045742 \Delta \text{ad}(\text{Lapin Kulta})$$

(0.054300)

$$- 0.008373 \Delta \text{ad}(\text{Karhu}) + 0.020192 \Delta \text{ad}(\text{Olvispecial}) + \varepsilon_t$$

(0.054300) (0.02836)

Appendix 4

FIML estimates for static, long-run elasticities for sales: log of sales, log of advertising expenditure. Numbers in parenthesis are standard errors:

$$\Delta \text{s}(\text{Koff3}) = 0.0023511 + 0.096626 \Delta \text{ad}(\text{Koff3}) + 0.048773 \Delta \text{ad}(\text{Olvispecial}) \quad (\text{A5})$$

(0.016482) (0.097450) (0.056267)

$$+ 0.0094064 \Delta \text{ad}(\text{Lapin Kulta}) - 0.015485 \Delta \text{ad}(\text{Karhu}) + \varepsilon_t$$

(0.10694) (0.028376)

$$\begin{aligned} \Delta s(\text{Olvi special}) = & - 0.0012925 + 0.060079 \Delta \text{ad}(\text{Koff3}) \\ & (0.011738) \quad (0.069403) \\ & + 0.043547 \Delta \text{ad}(\text{Olvi special}) \\ & (0.0478165) \end{aligned} \quad (\text{A6})$$

Beer market
and advertising
expenditure

975

$$\begin{aligned} + 0.0011656 \Delta \text{ad}(\text{Lapin Kulta}) - & 0.0037506 \Delta \text{ad}(\text{Karhu}) + \varepsilon_t \\ (0.076165) & (0.020209) \end{aligned}$$

$$\begin{aligned} \Delta s(\text{Lapin Kulta}) = & 5.4558e - 005 + 0.10236 \Delta \text{ad}(\text{Koff3}) \\ & (0.0014006) \quad (0.082814) \\ & + 0.039831 \Delta \text{ad}(\text{Olvi special}) \\ & (0.047816) \end{aligned} \quad (\text{A7})$$

$$\begin{aligned} - 0.0061038 \Delta \text{ad}(\text{Lapin Kulta}) - & 0.0070045 \Delta \text{ad}(\text{Karhu}) + \varepsilon_t \\ (0.090883) & (0.024114) \end{aligned}$$

$$\begin{aligned} \Delta s(\text{Karhu}) = & 0.029189 - 0.0031974 \Delta \text{ad}(\text{Koff3}) + 0.087423 \Delta \text{ad}(\text{Olvi special}) \\ & (0.02716) \quad (0.16039) \quad (0.092606) \end{aligned} \quad (\text{A8})$$

$$\begin{aligned} - 0.11359 \Delta \text{ad}(\text{Lapin Kulta}) + & 0.00045650 \Delta \text{ad}(\text{Karhu}) + \varepsilon_t \\ (0.17601) & (0.046702) \end{aligned}$$

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