ADVERTISING DECISIONS IN AN OLIGOPOLISTICALLY COMPETITIVE INDUSTRY: CASE OF UKRAINIAN CIGARETTE PRODUCERS

by

Rostislav Khomenko

Master of Arts in Economics

National University of "Kyiv-Mohyla Academy"
Economics Education and Research Consortium
Master's Program in Economics

2003

Approved by _____
Ms.Svitlana Budagovska (Head of the State Examination Committee)

_____

_____

_____

Program Authorized
to Offer Degree Master's Program in Economics, NaUKMA

Date _____

National University of "Kyiv-Mohyla Academy"

Abstract

ADVERTISING DECISIONS IN AN OLIGOPOLISTICALLY COMPETITIVE INDUSTRY: CASE OF UKRAINIAN CIGARETTE PRODUCERS

by Rostislav Khomenko

Head of the State Examination Committee: Ms.Svitlana Budagovska,
Economist, World Bank of Ukraine

This paper examines advertising decisions of Ukrainian cigarette producers using the framework developed by Roberts and Samuelson (1988). Besides the obvious importance of the advertising efficiency to the firms, the problem is also important to the government: it is still unclear whether smoking prevention policy measures such as advertising bans are effective. The results indicate that cigarette advertising has a "public good" nature (i.e. it increases the total sales of cigarettes, but has no effect on the advertiser's market share). The estimates of the behavioral parameters of the firms suggest that firms take into account the future rival free-riding in their advertising decisions. The non-cooperative equilibrium results in advertising efforts that are lower compared to those under a cooperative equilibrium. Results of the analysis suggest that collusion among the cigarette producers would increase the market demand and the profits of the firms. The results give support for the cigarette advertising bans as a way to decrease smoking rates and suggest collusion preventing policies as another measure of smoking prevention.

TABLE OF CONTENTS

Number *Page*

LIST OF TABLES

Number Page

LIST OF FIGURES

Number *Page*

ACKNOWLEDGMENTS

The author expresses sincere appreciation to Professor Roy Gardner for his thorough guidance in the preparation of this paper. In addition, I would like to thank Professor Tom Coupe for his valuable comments on the earlier drafts of this paper. Special thanks to Julia Khrustaleva and Anna Babinchuk for inspiring the idea and giving insightful suggestions.

Chapter 1

INTRODUCTION

Today it is widely believed that in many industries competitor's advertisements tend to cancel each other out leaving industry sales almost unchanged. In the mean time, expensive marketing campaigns increase costs and thus lower firms' profits. A well-known marketing guru David Ogilvy once said: "Half the money spent on advertising is wasted; the problem is identifying which half"[1]. There are also cases of homogeneous goods advertising that increases the overall market demand but has no impact on the advertising firms' market share. In such setting a free-rider problem results in lower then optimal equilibrium advertising efforts.

This paper looks at the advertising competition in the case of Ukrainian cigarette producers. The objective of the study is to research the optimality and rationality of the current advertising decisions in the cigarette industry using the game theory models of oligopolistic competition.

The role of advertising is especially important in a non-pricing-competitive environment in which many brands are produced too promote product differentiation. The cigarette industry is generally believed to be a good example of such environment. Besides the obvious importance of the advertising efficiency to the firms themselves, the problem is also important to the government: it is still unclear whether smoking prevention policy measures such as advertising bans are effective.

---

[1]See "Strategic Game Theory for Managers" lectures at Australian Graduate School of Management www.agsm.edu.au.

Results of the research could have significant policy implications for the Ukrainian cigarette producers, who currently spend a considerable share of their budgets on advertising. Cigarette industry is also quite important for the Ukraine's economy - it makes up over 17% of the food industry, and contributes about 3% of total budget revenues (ICPS, 2000).

The structure of the thesis is as follows. Chapter 2 reviews relevant approaches to the problem literature and go over previous empirical results. Chapter 3 presents a theoretical model based on the framework developed by Roberts and Samuelson (1988). Chapter 4 contains an attempt at testing the hypothesis formulated in Chapter 3 on Ukrainian data. Finally, conclusions are drawn in Chapter 5.

Chapter 2

LITERATURE REVIEW

The researchers were interested in the way the firms interact in the oligopolistic environment ever since Cournot's development of a static model of interdependence where firms maximize profits choosing output simultaneously and independently. Later Bertrand has designed an oligopoly game where prices were used as the main strategic rivalry weapons. Further advancements in the game theory led to the development of the differential games framework, which allowed for analysis of interaction with multiple strategic weapons such as price, advertising and new product development.

The earliest critique of advertising decisions as leading to excessive levels of promotion can be found in Clark (1925). The paper recognized the two ways in which advertising affects the firm's sales. When advertising effort is directed at consumers who have not bought the product before, it has the effect of increasing total market size (it provides information about the very existence of the product, its price and general characteristics). However, when advertising is directed at a rival's clientele, it has a business stealing or "predatory" effect. Later in the literature this natures of advertising are generally referred to as "cooperative" and "predatory".

Contemporary literature on advertising competition can be broadly categorized in two streams. The first category of studies has focused on the econometric estimation of the sales response to advertising attempting to determine optimal advertising levels based on the estimates response function (Vidale and Wolfe

(1957), Nerlove and Arrow (1962), Brown (1978), Nguyen (1987) Steenkamp, Nijs, Hassens and Dekimpe (2002). The second category of more recent theoretical developments employed differential games framework to examine the equilibrium advertising expenditure paths for the competing firms (Roberts and Samuelson (1988), Chintagunta and Vilcassim (1992), Slade (1995), Espinoza and Mariel (1996), Piga (1998)).

The models of sales response to advertising that appear in the literature can be classified in the two broad types. The first type is a competitive extension of the Vidale and Wolfe (1957) framework based on the Lanchester model of battle strategy. According to this model, only current advertising expenditures affect the firm's market share, the change in sales in a given time period can be decomposed as the sales gained from competitors due to the firm's own advertising and the sales lost from due to advertising of competitors.

The second type formulation is the stock decay or "goodwill" model developed by Nerlove and Arrow (1962). This framework for advertising-sales relationships treats advertising as a stock of depreciating goodwill. Because goodwill is slow to develop and depreciates slowly over time, once established, the impact of an advertising investment made in one period can be felt for many more periods into the future. Nerlove-Arrow models appear to be difficult to apply because the level of advertising goodwill could not be observed directly and it's rate of depreciation was difficult to estimate. On the other hand, the Lanchester approach is very restrictive because it allows for only a limited number of rivals and weapons, and implies no aggregate sales effect.

Brown (1978) used a specification based on the Nerlove-Arrow approach to explore the scale economies in advertising in the cigarette industry. He modeled the sales levels of the cigarette producers to be dependent on the firm's own and

rival goodwill stocks. A major advancement of his work was the use the Koyck transformation to express current goodwill levels through current advertising expenditures and lagged sales. In previous papers the stocks were approximated by variables such as the weighted sum of past advertising expenditures and the age of brands. The paper found the competitor's advertising to have negative and significant effect.

Roberts and Samuelson (1988) modeled advertising interaction in cigarette industry while addressing the question of whether firms take into account rivals' future responses when choosing the levels of advertising goodwill. They used a specification of the advertising-sales relationship similar to that of Brown (1972). Levels of advertising goodwill also entered the firms' profit equations through revenues (affecting product demand) and costs (cost of supporting the desired level of goodwill). The interdependence of the advertising decisions of the competing firms was modeled through a "dynamic conjectural variation" that was first used by Riordan (1985) to summarize the intertemporal link in firm's actions that arise from the use of strategies that depend on past actions of rival firms. A Nash equilibrium in this model required each firm's pair of sequences of goodwill stocks be optimal given the sequences of other firms. The results of Roberts and Samuelson suggested that advertising has a strong cooperative content (i.e. only the market size effect was significant). Dynamic conjectural variation terms appeared to be significant for all the cigarette producers meaning that the firms acted strategically when choosing advertising levels. The tests for joint non-cooperative profit maximization hypothesis were not rejected.

Chintagunta and Vilcassim (1992) have linked the econometric estimation of the sales response to advertising functions to the differential games framework, which allowed for analysis of equilibrium expenditures in the dynamic duopoly in the case of Coke and Pepsi. The paper used the Vidale and Wolfe (1957)

framework of sales responses assuming that the market share of the competitors evolves according to the Lanchester model of combat. Chintagunta and Vilcassim (1992) than derive the equilibrium advertising expenditures under both - open-loop and closed-loop strategies and compare them to the actual spending levels. The results suggest that the closed-loop strategies give a better fit for the actual advertising levels and thus are more appropriate for the analysis of advertising competition. The drawbacks of the model developed by Chintagunta and Vilcassim (1992) is that it allows only for two players and a single strategic weapon.

Slade (1995) analyzed dynamic rivalry where firms use prices as well as advertising as the main strategic tools. As alternative to the Koyck transformation, she used the lagged multi-period advertising expenditures as the way to account for the goodwill stocks. She finds the nature of advertising for saltine crackers to be "mildly predatory" resulting in an overinvestment in advertising goodwill stocks by retail-grocery stores. At the same time she concludes that the dynamic-strategic considerations lead the same firms to compete less in price.

Espinoza and Mariel (1996) develop a model based on the differential games framework and examine the three-cases: perfectly cooperative, perfectly predatory and balanced advertising effects. The comparison of the outcomes is done using the open-loop and the Markov perfect equilibriums. The open-loop and feedback equilibrium strategies of the model proposed are then compared to the actual advertising expenditures of two major competitors in the German automobile industry (Volkswagen-Opel GM).

Chapter 3

THEORETICAL MODEL

This study of advertising decisions of the Ukrainian cigarette producers for the most part relies on the framework developed by Roberts and Samuelson (1988), which in turn is based on the works of Nerlove and Arrow (1962) and Riordan (1985).

We consider the market to be an oligopoly in which the firms compete by the means of prices and advertising. In the Nerlove and Arrow tradition advertising is modelled as an investment that accumulates over time and forms a stock of goodwill that is subject to depreciation. I[th] firm stock advertising goodwill at time t is expressed as:

$$G_{it} = \lambda G_{it-1} + A_{it} \qquad (1)$$

where A_{it} is the current period advertising and $\lambda \in (0;1)$ is a rate at which the last period stock of advertising goodwill depreciates. The rival firms' stock of advertising goodwill at time t is denoted as:

$$GR_{it} = \sum_{j \neq i}^{n} G_{jt}, \; i \neq j$$

The market total stock of advertising goodwill at time t is denoted as:

$$GT_t = \sum_{j=1}^{n} G_{jt}$$

Market demand for the product at time t is dependent on the total stock of advertising goodwill (GT), the average market price (P) and a set of exogenous factors such as population, consumer income and prices of the complementary products, which are included in the term z_t:

$$Q_t = Q_t(GT_t, P, z_t) \qquad (2)$$

Market share of the i^{th} firm at period t depends on its own advertising goodwill stock at period t (G_{it}), the cumulative stock of the advertising goodwill of rival the firms (GR_{it}), the firm's price (P_{it}), the average price of rivals (PR_{it}) and the firm-specific exogenous factors Z_{it}:

$$S_{it} = S_{it}(G_{It}, GR_{it}, P_{It}, PR_{it}, Z_{it}) \qquad (3)$$

I^{th} firm demand at time t is than expressed as its share of the total market demand using equations (2) and (3):

$$q_{it} = Q_{kt}(GT_t, P, z_t) \times S_{it}(G_{It}, GR_{it}, P_{It}, PR_{it}, Z_i) \qquad (4)$$

The simple setting: no strategic interdependence

We now proceed with deriving conditions for the profit maximizing paths of prices and advertising. First, we will derive the profit maximization conditions for the case when the rivals' policy choices are not interdependent, and than complicate these conditions by incorporating strategic interdependence.

Profit of the i^{th} firm at time t is expressed as revenue after subtracting production costs and advertising expenditures:

$$\pi_{it} = p_{it}q_{it} - c_{it} - \varphi_i \qquad (5)$$

where:

$q_{it} = q_{it}(Gi_t, p_{it}, z_{it})$ - quantity of the product sold

$c_{it}(q_{it})$ - production cost,

$\varphi_{it}(G_{it} - \lambda G_{it-1})$ - cost of supporting the desired level of advertising goodwill

In the dynamic setting each firm chooses time paths for its price and stock of advertising goodwill so as to maximize the discounted sum of the future profits:

$$V\{p,G\} = \int_0^{\infty} e^{-rt}\left[p_{it}q_{it} - c_{it} - \varphi\right]dt \qquad (6)$$

subject to:

$G_{it} = \acute{r}\ddot{I}\ddot{I}G_{-1} + A_{it}$

and initial conditions:

$P(0) = P_0$

$G(0) = G_0$

Since profits in each period depend only on current price, the optimal price policy can be found by maximizing the static profit with respect to price while holding the advertising goodwill constant:

$$\frac{\partial \pi_{it}}{\partial P_{it}} = (p_{it} - mc_{it}) \frac{\partial q_{it}}{\partial P_{it}} + q_{it} = 0\,, \qquad (7)$$

where $q_{it} = q_{it}(G_{it}, p_{it}, z_{it})$.

The equation above presents the usual profit-maximising condition equating marginal revenue to marginal cost.

Next we derive the profit-maximizing path of advertising goodwill stock by plugging derived from (7) optimal price policy $p_{it}^* = p_{it}(G_{it}, z_{it})$ into (5).

We define the revenue after subtracting the production cost as $R_{it}(G_{it}, z_{it}) = p_{it}^*(G_{it}, z_{it}) \times q_{it}(G_{it}, p_{it}^*(G_{it}, z_{it}), z_{it}) - c_{it}(q_{it}(G_{it}, p_{it}^*(G_{it}, z_{it}), z_{it}))$ and construct a new maximization problem:

$$V\{G\} = \int_0^{\infty} e^{-rt} \left[R_{it}(G_{it}, z_{it}) - \varphi(G_{it} - \lambda G_{it-1}) \right] dt \qquad (8)$$

subject to:

$$G_{it} = \lambda G_{it-1} + A_{it}$$

and an initial condition:

$$G(0) = G_0$$

The optimal advertising goodwill path for this maximization problem is defined in Nerlove and Arrow (1962) and rewritten in Roberts and Samuelson (1988) as:

$$\frac{\partial \pi_{it}}{\partial G_{it}} = (p_{it} - mc_{it}) \frac{\partial q_{it}}{\partial G_{it}} - \frac{\partial \varphi_{it}}{\partial G_{it}} + D_{t+1} \lambda \frac{\partial \varphi_{it+1}}{\partial G_{it}} = 0\,, \qquad (9)$$

where D_{t+1} - discount rate

The first term in the equation above is the change in the level of output sold due to the change in stock of advertising goodwill times mark-up, the second term is the advertising expenditure needed achieve the desired period t stock of goodwill and the last term is the decrease in the period t+1 goodwill support cost due to the increase in the current period stock.

So, in case of no strategic interdependence between the firms in the market a typical firm would be choosing the price and the stock of the advertising goodwill simultaneously according to the conditions (7) and (9). Next we consider the case of strategic interdependence between the firms in the market, which is typical for oligopolistic environment.

The complex setting: introducing strategic behaviour

As stated in the equation (4) the quantity of the output sold by the firm also depends on the actions of its rivals, who may influence the firm's output by altering the stocks of advertising goodwill (GR and total market goodwill GT), and prices (PR and average market price P).

In the case the firm recognizes the strategic interdependence, it expects its rivals to react to its current actions in the next period. In the Nash equilibrium, the fir would chose the optimal pair of sequences of prices and advertising stocks, given the sequences chosen by rival firms. This strategic awareness is represented by a presence of additional terms in the first order condition that account for perceived future rival reactions. For example, when a firm perceives that it's current changes in the advertising goodwill stock will alter the future rival stocks and the future rival price, three additional terms are added to the first order condition for optimal advertising (9):

Term 1 = $(p_{it} - mc_{it})\frac{\partial q_{it}}{\partial G_{it}} - \frac{\partial \varphi_{it}}{\partial G_{it}} + D_{t+1}\lambda\frac{\partial \varphi_{it+1}}{\partial G_{it}}$ - is equal to the first order condition of the naive firm (9).

Term 2 = $D_{t+1}\sum_{j\neq i}^{n}\left[(p_{it+1} - mc_{it+1})\frac{\partial q_{it+1}}{\partial G_{it+1}}\right]\frac{\partial G_{jt+1}}{\partial G_{it}}$ - represents the effect on the firms profits of change in the rival advertising goodwill stock in the period t+1 in response to the change in the firm's own stock in the current period.

Term 3 = $D_{t+1}\sum_{j\neq i}^{n}\left[(p_{it+1} - mc_{it+1})\frac{\partial q_{it+1}}{\partial p_{jt+1}}\right]\frac{\partial p_{jt+1}}{\partial G_{it}}$ - represents the effect on the firms profits of change in the rival price in the period t+1 in response to the change in the firm's own stock in the current period.

Term 4 = $\sum_{t+2}^{\infty} D_{it}\left(\frac{\partial \pi_{it+1}}{\partial G_{jt+1}}\frac{\partial G_{jt+1}}{\partial G_{it}}\right) + \sum_{t+2}^{\infty} D_{it}\left(\frac{\partial \pi_{it+1}}{\partial p_{jt+1}}\frac{\partial p_{jt+1}}{\partial G_{it}}\right)$ - simplicity represents the effects of strategic response in the periods following t+1.

The complete first order condition for the firm characterized by a strategic behavior becomes:

Term 1 + Term 2 + Term 3 + Term 4 = 0 (10)

.

The terms $\frac{\partial G_{jt+1}}{\partial G_{it}}$ and $\frac{\partial p_{jt+1}}{\partial G_{it}}$ in terms are called "dynamic conjectural variations"[2] and represent the perceived rival future responses to the change in the current period strategic variables of the firm. In case the dynamic conjectural variations are zero, equation (10) would coincide with the equation (9). There are four possible types of responses which enter the first-order conditions for optimal price and advertising paths:

- $\frac{\partial G_{jt+1}}{\partial G_{it}}$, i≠j – the rivals could respond to the firm's current change in the advertising goodwill stock by altering their next period advertising goodwill stock.

- $\frac{\partial P_{jt+1}}{\partial G_{it}}$, i≠j – the rivals could respond to the firm's current change in the advertising goodwill stock by altering their next period price.

- $\frac{\partial P_{jt+1}}{\partial P_{it}}$, i≠j – the rivals could respond to the firm's current change in price by altering their next period price.

- $\frac{\partial G_{jt+1}}{\partial P_{it}}$, i≠j – the rivals could respond to the firm's current change in price by altering their next period advertising goodwill stock.

According to Slade (1995), the instruments of rivalry are said to be strategic complements (substitutes) if the best reply functions slope up (down). For example, competition with respect to strategic variable G_{it} is said to be complementary if:

[2] See Riordan 1984 for a complete discussion of the matter

$\frac{\partial G_{jt+1}}{\partial G_{it}} > 0$ - the rivals would increase the t+1 stock of advertising goodwill in response to the increase in the firm's current level stock. This would result in "prisoners dilemma" situation and overinvestment in advertising.

Contrary, in the case of strategic substitutes ($\frac{\partial G_{jt+1}}{\partial G_{it}} < 0$) the rivals would decrease the t+1 stock of advertising goodwill in response to the increase in the firm's current level stock. This would result in free-riding and underinvestment in advertising.

Similar to the equation (10), the "dynamic conjectural variations" can be added to the first-order condition for the optimal price (7).

The theoretical setting described above allows us to test empirically two hypotheses about the firm behaviour:

(1) The firms behave strategically if the "dynamic conjectural variations" are nonzero (i.e. $\frac{\partial G_{jt+1}}{\partial G_{it}} \neq 0$)

(2) If firms do act strategically, than it is useful to ask whether the goodwill stocks chosen correspond to the join profit maximization condition. The joint profits are maximized with respect to advertising in case the marginal benefit of advertising is equal to the marginal cost (i.e. equation 9) for all firms:

$$\sum_{I=1}^{4} \left[(p_{it} - mc_{it}) \frac{\partial q_{it}}{\partial G_{it}} - \frac{\partial \varphi_{it}}{\partial G_{it}} + D_{t+1} \lambda \frac{\partial \varphi_{it+1}}{\partial G_{it}} \right] = 0 \qquad (11)$$

In the next section we proceed with the empirical estimation of the theoretical model and the testing of the hypotheses described above.

Chapter 3

EMPIRICAL ANALYSIS

Profile of the Ukrainian cigarette market

Ukrainian cigarette market can be considered a good example of oligopoly: out of 17 operating factories, 10 are members of the Ukrainian association of tobacco producers ("Ukrtutun"). Those ten factories account for over 99% of the industry's output. The ten factories in turn can be divided into two groups: (1) factories owned by multinational corporations - 5 factories producing over 90% of total output; and (2) factories without foreign capital. Multinational firms dominate in the market (concentration in the market is rather high), production at the factories without foreign capital is shrinking, while the major competition exists among multinationals. The Herfindahl-Hirschman Index computed in Table 1 exceeds 1800, which is a threshold for oligopoly according to US antitrust law.

Table 1. Industry Shipments by Producer (million sticks per year)

Year	2000	2001	2002
Total Industry Shipments	52,448	65,984	73,554
Market shares by firm:			
Philip Morris	30%	30%	30%
Reemtsma/Imperial	34%	31%	28%
British-American Tobacco	15%	22%	22%
JT International	12%	10%	10%
Gallaher	0%	0%	1%
Other	8%	7%	10%
5-firm HHI	2425	2445	2269
Total Market HHI	2433	2452	2280

Firm profiles

British-American Tobacco (BAT) in Ukraine has a factory with an estimated capacity of 20.5 bn sticks per year. BAT invested round $50 m 4 since the 1993 - the beginning of its investments in Ukraine. The number of employees is about is 950.

Gallaher has actively entered the Ukrainian market in the end of 2001 with the acquisition of Cherkassy TF from Imperial. The factory capacity is at around 10 bn units per year. Gallaher main volumes are derived from low-margin segments. The company is not included in the current study because it operates in Ukraine for only a year and its historical performance period is insufficient for the estimation procedure.

Japan Tobacco International (JTI) has entered Ukrainian market in 1993. The estimated capacity of Kremenchuk Tobacco Factory is 10 bn/year. The headcount is approximately 750 people.

Philip Morris has started operations in Ukraine in 1994. Total investments in Ukrainian operations are estimated at $63.9 m. The factory capacity is around 19 bn sticks a year. The company employs 1100 people.

In May 2002 German **Reemtsma (REE)** was taken over by **Imperial Tobacco** company. The deal was one of the largest in the history of world tobacco business: Imperial acquired 90% of Reemtsma with an option to purchase the remaining shares for a total deal valued at 5.8 billion Euro. Reemtsma entered the Ukrainian market in 1993 and since then has invested about $100 m in its operations. The company has a factory in Kyiv with a capacity of 30 bn units per year. The whole company portfolio except Davidoff family and R1 Slim Line is

produced locally. The number of employees is about 1350 people. As for company's portfolio, it is mostly concentrated within lower price/local segments

Data

The data set consists of monthly data for the period from January 2000 to December 2002 for a total of 36 observations for each of the four cigarettes producers (Philip Morris, BAT, Reemstma, JTI). Reliable statistical data for the earlier time period is not available.

The data set includes the following variables:

- domestic sales of legal[3] cigarettes in Ukraine (million sticks).

- weighted average price of cigarettes by producer (hryvnias per million sticks). Average prices were calculated using market shares of different types of cigarettes as weights.

- nominal advertising expenditures in outdoor media by firm (hryvnias per 2-week board).

- real advertising expenditures in outdoor media by firm (number of boards purchased[4]). Cigarette advertising on TV is banned in Ukraine, so outdoor media

[3] According to ICPS 2000, up to 25% of cigarettes were imported into the country illegally in 1995-1999. However, according to industry estimates, the share of illegal imports has been declining significantly in 2000-2002.

[4] Although a more appropriate measure for the real advertising expenditure would the number of "opportunities to see" (OTS) purchased by a firm, this data is available only for the period of 2001-2002. The price per board purchased by each firm during the period is highly correlated with the price per OTS, this allows us to extend the dataset for a year 2000 by using prices and quantities of boards instead of OTS.

accounts for over 90% of all advertising expenditures with print media accounting for the rest.

- average marginal contribution by firm (hryvnias per million sticks). Marginal contribution is the difference between the price and production cost. Average nominal contribution was calculated by weighting the profits per pack of different types of cigarettes by their market shares. This data is available on annual basis only.

Table 2. Summary Measures of Output, Advertising and Prices, 2000-2002

	Firm Means			Average Annual Growth Rates 2000-2002	
	Market Share	Advertising Share	Price, UAH per pack	Output	Advertising Quantity (number of boards)
Philip Morris	30%	31%	2,39	19%	-16%
Reemstma/Imperial	31%	18%	1,44	8%	29%
BAT	20%	23%	1,44	43%	-15%
JTI	10%	19%	2,03	6%	-46%

The data on prices, market shares, real and nominal advertising expenditures was collected by ACNeilsen. The output quantities and estimated production costs were taken from a market research unit of one of the cigarette producers.

It is important to discuss several properties of the dataset. There are significant differences among the firms in market shares, advertising shares and prices (Table 2). The brand portfolio of Philip Morris (Marlboro, Parliament) and JTI (Camel, Winston) is concentrated in the premium segment, which results in the higher average price of output. The fact of existence of several prices in the market is consistent with the theory once advertising is taken into account – a higher priced

output also requires a larger share of advertising expenditures in order to keep the sales constant.

An important stylised fact about the cigarette industry is a so cold "non-price competition"[5] – the firms compete on advertising quantities rather than on prices. This fact is supported by the data from Ukrainian market where advertising quantities have fluctuated significantly during the period, while prices remained stable (Figure 1). The implication of the stylised fact of the 'non-price competition' is the possibility to model prices as exogenous to the model and to concentrate exclusively on the advertising competition[6], assuming apriori that all the dynamic conjectural variations in (10) are zero except for $\frac{\partial G_{jt+1}}{\partial G_{it}}$.

Empirical model

The purpose of our empirical model is to estimate the effects of advertising and the corresponding behaviour of firms, who make the advertising decisions. For this purpose we would need to construct the following equations:

- (1) a total demand equation that would capture the effects of advertising on the aggregate demand for cigarettes.

- (2) a market share equation that would capture the affects of advertising on the firm's market share.

[5] According to Berndt (1991), in oligopolistic industries (such as cigarette and beer) price competition is rare.

[6] Berndt (1991) argues that marketing models that focus on advertising treating prices as exogenous should be viewed as no more restrictive as economic models that concentrate on prices ignoring advertising. Stable prices were also used as an argument for not explicitly modelling the pricing decisions in Roberts and Samuelson (1988).

- (3) a first-order condition for the optimal stock of advertising goodwill in order that would help us to asses the firm's perception of the future rival responses.

The empirical model would be a 9-equation simultaneous panel system consisting of an aggregate demand equation, a market share equation and FOC equation for each of the four major Ukrainian cigarette producers.

The market share equation is presents the firms' market share as dependent on it's advertising goodwill stock, the stock of goodwill of its rivals, the firm's price and the average rival price:

$$S_{it} = \beta_i^* + \beta_{a0} G_{it} + \beta_{ar} GR_{it} + \beta_{p0} P_{it} + \beta_{pr} PR_{it} \qquad (12)$$

The equation above is similar to the one of Roberts and Samuelson (1988), however, we do account for price differences among the firms and do not account for the number of brands produced by each firm. The important feature of the equation is that we cannot directly observe the advertising goodwill stocks. In order to coop with this problem we apply a Koyck transformation[7] by subtracting λS_{it-1} from the original equation:

$$S_{it} - \lambda S_{it-1} = \beta_i^* - \lambda\beta_i^* + \beta_0 (G_{it} - \lambda G_{it-1}) + \beta_r (GR_{it} - \lambda GR_{it-1}) +$$
$$+ \beta_{p0} (P_{it} - \lambda P_{it-1}) + \beta_{pr} (PR_{it} - \lambda PR_{it-1}) \Rightarrow$$

$$S_{it} = \beta_i + \beta_0 A_{it} + \beta_r AR_{it} + \beta_{p0} (P_{it} - \lambda P_{it-1}) + \beta_{pr} (PR_{it} - \lambda PR_{it-1}) + \lambda S_{it-1} \qquad (13)$$

where $\beta_i = \beta_i^* (1 - \lambda)$,

[7] See Berndt for a discussion of the Koyck transformation.

A_{it} – quantity of i^{th} firm advertising at period t,

AR_{it} – quantity of rival advertising at period t.

The transformed equation presents market share as dependent on the current period advertising quantities and the previous period market share. All of the independent variables in this equation are observable and so it can be estimated. In estimating the equation we will assume that the effects of advertising and the goodwill decay rate are equal across firms.

The aggregate demand equation presents the total demand as dependent on the total advertising goodwill stock at time t and the average price of:

$$Q_t = \beta_i + \phi GT_t + \theta PT_t \qquad (14)$$

The problem with this equation is similar to the one with the market share equation (11) (i.e. the total stock of advertising goodwill can not be observed). Similar to the equation (11), we apply a Koyck transformation to decompose the goodwill stock into the current advertising and the lagged output:

$$Q_t = \beta_i * + \phi AT_t + \theta(PT_t - \lambda PT_{t-1}) + \lambda Q_{t-1} \qquad (15)$$

Similar to Roberts and Samuelson (1988), in order to estimate **the first order condition** we derive the effects of the firms own and rival advertising goodwill on its demand. For this purpose we use first-order derivates with respect to the firms product demand:

$$\frac{\partial q_{it}}{\partial G_{it}} = S_{it}\frac{\partial Q_t}{\partial GT_t} + Q_t\frac{\partial S_{it}}{\partial G_{it}} = S_{it}\phi + Q_t\beta_0 \qquad (16)$$

The first term in the equation above represents the effect of own advertising due to the changes in the total market demand. The second term represent the effect of the firms advertising due to the changes in its market share.

Similar derivative of the firms demand is taken with respect to the advertising goodwill of the rival firms:

$$\frac{\partial q_{it}}{\partial GR_{it}} = S_{it}\frac{\partial Q_t}{\partial GT_t} + Q_t\frac{\partial S_{it}}{\partial GR_{it}} = S_{it}\phi + Q_t\beta_R \qquad (17)$$

The demand curve derivatives obtained above are then used in the first-order condition (10) for the optimal choice of advertising goodwill for the "sophisticated" firm:

$$\tau_i + \frac{PMC_{it}}{P_{it}}(S_{it}\phi + Q_t\beta_0) - \frac{P_{Ait}}{P_{it}} + D_{it}\lambda\frac{P_{Ait+1}}{P_{it}} + D_{it}\frac{PMC_{it+1}}{P_{it}}(S_{it+1}\phi + Q_t\beta_R)\omega_i = 0 \quad (18)$$

where

τ_i - firm specific intercept, capturing the any omitted firm-specific variables and the term R_{it}

PMC_{it} - marginal contribution (p_{it}-mc_{it}),

ω - dynamic conjectural variation $\frac{\partial G_{jt+1}}{\partial G_{it}}$,

P_{Ait} - average price per advertising message.

D_{it} - discount rate.

To summarize, the complete system consists of the market share equation (13) and the first-order condition (18), which are simultaneously estimated for the four firms and a total demand equation (15) resulting in the total of nine equations.

$$\begin{cases} Q_t = \beta_i + \phi GT_t + \theta PT_t \\ S_{it} = \beta_i + \beta_0 A_{it} + \beta_r AR_{it} + \beta_{p0}(P_{it} - \lambda P_{it-1}) + \beta_{pr}(PR_{it} - \lambda PR_{it-1}) + \lambda S_{it-1} \\ \tau_i + \frac{PMC_{it}}{P_{it}}(S_{it}\phi + Q_t\beta_0) - \frac{P_{Ait}}{P_{it}} + D_{it}\lambda\frac{P_{Ait+1}}{P_{it}} + D_{it}\frac{PMC_{it+1}}{P_{it}}(S_{it+1}\phi + Q_t\beta_R)\omega_i = 0 \end{cases}$$

where *i=1,4*

Estimation and results

The obvious problem with estimating the model is that it is nonlinear in endogenous variables (Q_t, A_{it}, S_{it}). To estimate the parameters consistently we use a nonlinear system GMM method available in TSP 4.4. computer program. Instruments should correlate with endogenous variable and at the same time should be uncorrelated with the error term. The instruments used are the interest rate, real GDP, private consumption, value added of trade and catering, number of brands sold on the market, average price of advertising in outdoor and a time trend. The Sargan's test of overidentifying restrictions cannot be rejected at 10% significance[8]. Visual examination of prices of advertising reveals a structural break in 2000 (Figure 3), the corresponding Chow test of different intercepts cannot be rejected at 5% significance level. To control for this structural break we include a dummy variable for 2000 in the first-order condition equations. The discount rate

[8] Test statistic = 59.1299 (df=51)

for all four cigarettes producers is assumed to be constant across the firms and across the time and equal to an artificial constant (0.98). Latter we conduct a sensitivity analysis for this parameter.

Effects of advertising

Table 3 presents the estimates of the demand curve parameters. The first inference to be drawn out of the results is that the market share effect parameters of own and rival advertising are insignificant, while the market size effect parameter is positive and significant. The estimates for the market share effects are rather small indicating that an additional "big board" purchased has a very small effect on market share. Differences in market shares are better explained by prices than by advertising efforts. In essence, the results obtained support the argument towards the "public good" nature of advertising, meaning that rivals benefit from the firm's promotion efforts.

Table 3. Demand parameter estimates

		Estimate	S.E
Effects on market share			
Own advertising	Bo	.655027E-10	.331168E-06
Rival advertising	Br	.274370E-06	.228275E-06
Own Pice	Bpo	-.343170E-05**	.601476E-06
Rival Price	Bpr	.309434E-05**	.492487E-06
Market size effect			
	Φ	.038424*	.020770
	Θ	.018882	.083146
Goodwill decay rate	Λ	.920685**	.025520
Market Share Intercepts	Philip Morris	.037071**	.012301
	Remstma/Imperial	.018164**	.718162E-02
	BAT	.013598**	.475936E-02
	JTI	.014978**	.536959E-02
Market Demand Intercept		215.147	584.583

* - significant at 10%
** - significant at 5%

The second inference is that the advertising has long lasting effects – the monthly decay rate of the goodwill stock is over 92% corresponding to a 37% annual decay rate. This finding is consistent with previous studies (e.g. Brown 1978 found 41% annual decay rate).

We also test several joint hypotheses about the nature of advertising using Wald coefficient test. Results of the tests are presented in Table 4.

Table 4. Results of advertising and price effects
joint hypotheses tests

Hypothesis		**Test Statistic**
No Market Share Effects of Advertising	$\beta o=\beta r=0$	1.46375
No Market Share Effects of Price	$Po=Pr=0$	40.6031**

* - significant at 10%
** - significant at 5%

The joint hypothesis of no market share effects of advertising is rejected, while the joint hypothesis of no market share effects of price is not, which further supports our earlier findings of the "public good" nature of advertising. The "public good" nature of advertising should result in underinvestment in promotion in case the firms take into account future free-riding by rivals. To assess whether this is indeed the case, next we proceed with discussion and testing of the behavioural parameter estimates.

Firm Behaviour

Results of the estimated first-order condition equations for the four cigarette producers are presented in the Table 5. The dynamic conjectural variations for Philip Morris and BAT are negative and significant meaning that these firms do behave strategically. The corresponding coefficient estimates for Reemstma and JTI are insignificant, providing no support for the hypothesis that these firms take into account future rival free-riding.

Table 5. Behavioural Parameters Estimates.

	Estimate	S.E.
Dynamic Conjectural Variations		
Philip Morris	-1.15743**	.510261
Remstma/Imperial	.077609	.811541
BAT	-1.15354**	.418880
JTI	-1.53715	1.42555
FOC Intercepts		
Philip Morris	.135067E-02	.110366E-02
Remstma/Imperial	-.134923E-02	.109806E-02
BAT	.104090E-02**	.441031E-03
JTI	.150365E-02	.128788E-02
2000 Dummy	-.710292E-03**	.187435E-03

* - significant at 10%
** - significant at 5%

The results suggest a heterogeneous behavior of the industry players. The joint hypothesis that all the dynamic conjectural variations are jointly zero is rejected under 5% significance level.

Table 6. Firm behaviour joint hypotheses tests

Hypothesis			**Test Statistic**
All the dynamic conjectural variations are zero	$\omega_i = 0$	*i=1,4*	15.71766
Joint profits are maximized	Mean of Eq. (11)=0		2,535631

* - significant at 10%
** - significant at 5%

Negative dynamic conjectural variations of Philip Morris, BAT and JTI suggest that rival advertising quantities are strategic substitutes and that these firms believe that an increase in their current period advertising will lead to a lower and profit reducing equilibrium levels of advertising by the rivals in the next period. Such behaviour results in the lower than joint profit-maximizing levels of advertising by these firms. We test the hypothesis of joint profit maximization by testing whether the mean of equation (11) is equal to zero. The hypothesis is rejected under the 5% significance level. This result is somewhat contrary to the earlier findings of Roberts and Samuelson (1988), who found the dynamic conjectural variations to be negative and significant for the four out of five examined firms, but failed to reject the hypothesis of joint profit maximization.

Sensitivity analysis

The two important assumptions to test are the arbitrary chosen constant discount rate and the absence of price competition. We test the sensitivity of the model results to the discount rate assumption by plugging several different values for it into the original model. The assumption of no price competition is tested by excluding JTI from the system because of the fact that this firm has launched several premium brands during the period and in this way increased its average price of output. The results of sensitivity analysis are presented in Table 7.

Table 7. Results of the sensitivity analysis

		Changing discount Factor		Excluding JTI
		0.97	0.99	
Effects on market share				
Own advertising	Bo	.639345E-08	.644707E-08	.877812E-06
Rival advertising	Br	.277155E-06	.271846E-06	.578996E-06
Own Pice	Bpo	-.343027E-05*	-.343329E-05*	-.300225E-05*
Rival Price	Bpr	.309583E-05*	.309289E-05*	.339702E-05*
Market size effect				
	Φ	.038090*	.038783*	.036460*
	Θ	.019131	.018650	.109242
Goodwill decay rate	Λ	.921044*	.920339*	.924313*
Dynamic Conjectural Variations				
	Philip Morris	-1.17876*	-1.13572*	-1.60868*
	Remstma/Imperial	.111178	.043935	-.582747E-03
	BAT	-1.17207*	-1.13473*	-1.29181*
	JTI	-1.60454	-1.46858	

* - significant at 10%

Exclusion of JTI from the model does not change the significance of any coefficients, however, the dynamic conjectural variation of Reemstma changes the sign to negative. Changing the discount factor has no impact on the signs or the significance of coefficient estimates.

Chapter 5

CONCLUDING REMARKS

This paper studies advertising decisions of Ukrainian cigarette producers. The issues addressed are the effects of cigarette advertising on the market size and the market shares of the producers, and the firms' behavior under given nature of advertising. The model considers dynamic effects of advertising, representing it as a depreciating stock of goodwill. The strategic interdependence of the firms is modeled in line with the Roberts and Samuelson (1998) framework through the concept of dynamic conjectural variations.

The results indicate that cigarette advertising has a "public good" nature (i.e. it increases the total sales of cigarettes but has no effect on the advertiser's market share). Given such nature of the advertising, we would expect to observe free-riding behavior among the rival firms and lower-then-optimal advertising efforts in the non-cooperative equilibrium.

The estimates of the behavioral parameters of the firms suggest that at least two out of four studied firms take into account the future rival free-riding in their advertising decisions. The rival advertising efforts are found to be strategic substitutes.

Under the "public good" nature of advertising, the non-cooperative equilibrium results in advertising efforts that are lower compared to those under a cooperative equilibrium. Thus, collusion on advertising efforts would result in higher advertising levels and profits of the oligopoly.

There are important policy implications of the paper for the cigarette producers and the government. Cigarette producers could increase their profits if they could find a way to cooperate on advertising efforts. This however, would result in higher smoking rates and possible retaliatory smoking prevention and anti-monopoly regulatory measures taken by the government. Industry association of Ukrainian cigarette producers "Ukrtutun" currently serves only for the purposes of information exchange and does not function as advertising coordination tool. There are several possible explanations for the absence of collusion. Transaction costs of collusion across the countries could prove to be rather significant preventing global cooperation on advertising among the firms. The other reason might be the differences in the country strategies taken by the players (e.g. premium segments in some countries, low value/mass segments in others). Such differences may result in competitive clashes on taxation issues (e.g. fixed vs. percentage taxes) as well as on advertising (different target audiences) among the cigarette producers.

A policy implication for the government provided by this study is that advertising bans are indeed an effective way of smoking prevention because they lower the overall promotion activity and prevent increase in demand for cigarettes. The advertising ban measures might be taken further to reduce the smoking rates in Ukraine. The government should also prevent collusion among the cigarette producers to keep the advertising efforts low within the permitted media

Suggested improvements to the current study include market separation to study the advertising in different segments, explicit modeling of the cost functions and pricing decisions with the corresponding dynamic conjectural variations. Another improvement lies with testing the model on long-term (i.e. annual) data, and comparing the results obtained to those found for the monthly-frequency sample.

BIBLIOGRAPHY

Analysis of causes and effects of the illegal import and circulation of tobacco products in Ukraine. ICPS Research Report. 2000

Berndt, Ernst. *Econometrics: Classic and contemporary.* Addison-Welsey Publishing Company, Inc. 1991.

Chintagunta, P.K. and N.J. Vilcassim. *An Empirical Investigation of advertising Strategies in a Dynamic Duopoly.* Management science, 39, 1230-1244, 1992

Fred E. Clark *An Appraisal of Certain Criticisms of Advertising*, The American Economic Review, Vol 15 5-13, 1925.

Gardner, Roy. *Games for Business and economics.* John Wilely and Sons. 1995.

Green, William H. *Econometric Analysis*. Prentice Hall. 2000.

Jan-Benedict E.M. Steenkamp, Vincent R Nijs, Dominique M. Hanssens, Marnik G. Dekimpe. *Competitive Reactions and the Cross-Sales Effects of Advertising and Promotion.* ERIM Report Series in Research and Management. February 2002.

Nguyen, D. *Advertising, Random Sales Response, and Brand Competition: Some Theoretical and Econometric Implications.* The Journal of Business, Vol. 60 259-279, 1987

Nerlove M. and K.J. Arrow. *Optimal Advertising Policy under Dynamic Conditions.* Economica, new Series, Vol. 29, Issue114, 129-14, 1962.

M Paz Espinoza and P. Mariel. *A model of Optimal Advertising Expenditures in a Dynamic Duopoly.* Universidad del País Vasco, 1996.

Piga, C. *A Dynamic Model of Advertising and Product Differentiation.* Review of Industrial Organisation, 13, 509-22, 1998.

Randall S. Brown. *Estimating Advantages to Large-Scale Advertising.* The Review of Economics and Statisitics, Vol 60 428-437, 1978.

Roberts M. and L. Samuelson. *An Empirical Analysis of Dynamic, Nonprice Competition in an Oligopolistic Industry.* The RAND Journal of Economics, Vol. 19 200-220, 1988.

Slade M. *Product Rivalry with Multiple Strategic Weapons: An Analysis of Price and Advertising Competition,* Journal of Economics and Management Strategy, Vol. 4, Number 3, 445-476, 1995

"Strategic Game Theory for Managers" lectures at Australian Graduate School of Management www.agsm.edu.au.

Vidale, M.L., H.B. Wolfe. *An Operations Research Study of Sales Response to Advertising.* Operations Research, 5, 370-81, 1957.

APPENDIX

Figure 1. Average cigarette prices by firm, UAH per pack.

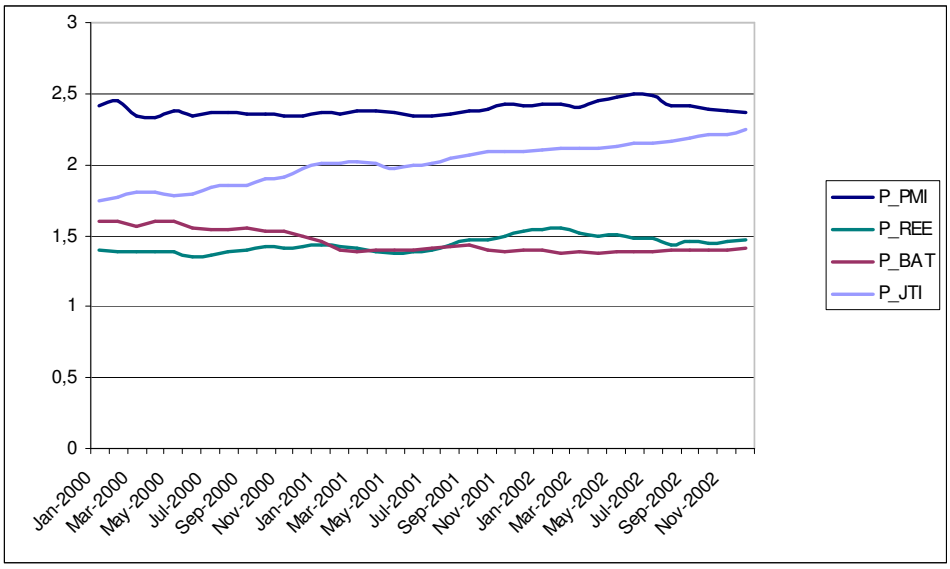

Figure 2. Monthly advertising quantities by firm, number of 2-week boards.

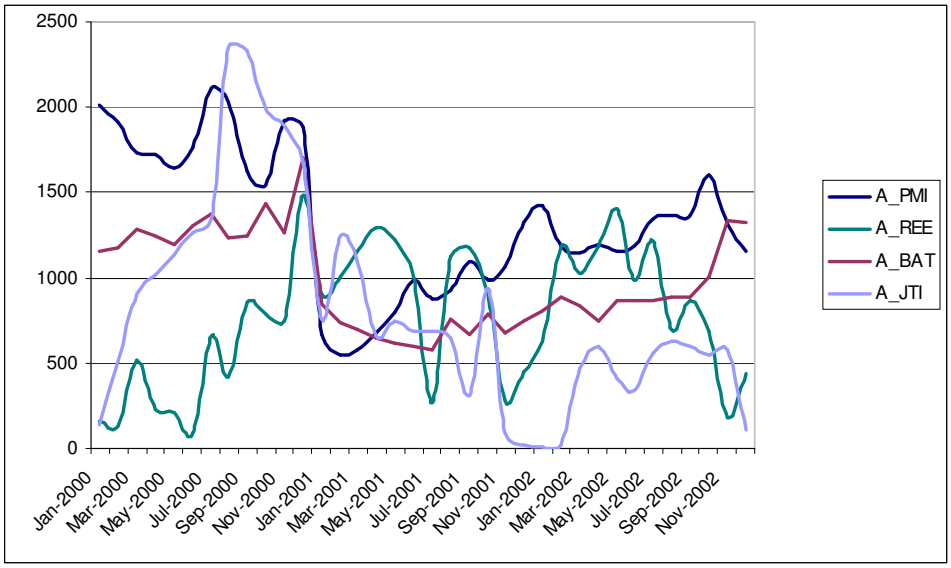

Figure 3. Monthly average advertising prices per 2-week board by firm (USD).