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TAX INCIDENCE IN DIFFERENTIATED GOOD OLIGOPOLISTIC MARKETS: THE CASES OF THE AUTOMOBILE MARKET IN ISRAEL

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Abstract

This paper introduces a new approach for investigating the effect of taxation in a differentiated product oligopoly. In such industries taxation effects the profile of goods which are produced and consumed as well as relative prices. In order to demonstrate these effects we consider the automobile market in Israel. Using structural estimation in which the post tax market equilibrium is numerically analyzed, we examine the effect of changes in the tax and custom regimes on the quantities sold in the market, on prices and on the types and the origin of cars. We demonstrate, in this paper, that such a procedure may provide new insight in particular when analyzing a differentiated product oligopoly.

Introduction

The incidence of taxation and the design of optimal tax system have been extensively discussed in the literature but mainly within a competitive market setting (see Auerbach (1987), and Summers (1987) for surveys) or within a homogenous good (Cournot type) oligopoly (e.g. Katz and Rosen (1983), Stern (1987) Myles (1987)). In a differentiated good oligopoly, the effect of taxation can be more complex as the taxation may affect not only the prices but also the profile of products that are sold in the market

In order to illustrate the complex effect of taxation on differentiated good oligopoly consider the automobile industry. Let us assume that in the relevant market, there are several firms that sell automobiles. Each of the firms sells different models. The models are vertically differentiated such that they differ in size, quality, etc. At any given period these firms compete in prices. The price vector determines how many cars of each model are sold. Thus in determining the price for a specific model, each firm needs to take into account the effect of the price of a particular model on its other models. Now assume that there is a tax imposed on cars. This tax can depend on the size of the car and even may depend on the country of origin. The effect of a change in taxation policy is not straight forward. It will change the market equilibrium and this may change not just the prices of cars but also the distribution of the types of cars that each firm sells. In particular, it is possible that a uniform increase in the sales tax, while reducing overall sales in the market, may increase sales of particular model. Such an effect will occur if as a result of the tax increase there is a shift of sales towards small cars. If one of the firms is

specialized in small cars, then although there is an additional tax on small cars, it is possible that the movement of consumers from compact to small cars implies an overall increase in sales.

This paper investigates a duopolistic market with vertically differentiated products in which each firm (potentially) sells multiple brands. The paper investigates, in this setting, the effect of commodity taxation on the quality of the products produced by the firms. In our setting there are several products (of different qualities).

We consider the automobile market in Israel. We analyze the effects of different changes in the tax and custom regimes on the quantities sold in the market, on prices and on the types and the origin of cars. In order to do so we adopt the following procedure: we first present a model of oligopolistic competition in this market. This model is similar to the one used in our previous work (Fershtman and Gandal (1997)) and is based on Berry (1994); we use the model and data on prices, quantities, and characteristics for 1994 and 1995 to estimate the demand and cost parameters for this market.

Given the estimated parameters, we analyze the effects of different tax regimes by simulating the market equilibrium under different such regimes. Specifically, we investigate the effect of three possible reforms. The first reform makes taxation uniform for all cars. The second reform is a 10% increase in the tax rate, while the third is an across the board reduction of 30% in the tax rate. For each of these cases we analyze the effect on the distribution of cars sold in the market, on prices, and on market shares of different manufacturers.

2. The Oligopolistic Model.[1]

We model the automobile industry as an oligopolistic market with N multiproduct firms. Firms compete through prices. The demand is an aggregation of a discrete choice model of consumer behavior.

2.1 Demand

Following Berry (1994), we use a random coefficient utility model, in which the utility of product j to consumer i, u_{ij}, is:

$$u_{ij} = x_j - \alpha p_j + \xi_j + \varepsilon_{ij} + x_j(\beta_i - \beta), \tag{1}$$

where x_j is a vector of observed product characteristics and p_j is the price of automobile j. The error terms are: ξj is the average value of product j's unobserved characteristics, ε_{ij} represents the distribution of consumer preferences around this mean, while $x_j(\beta_{iu} - \beta)$ captures consumers heterogeneity in the valuation of the observable characteristics. The terms ε_{ij} and $x_j(\beta_{iu} - \beta)$ introduce heterogeneity and their distribution determines the substitution patterns among products. Using the multinomial logit model, we assume that

[1] Sections 2 and 3 are from Fershtman and Gandal (1997).

$\beta_{iu} \equiv \beta$ for all i, and that ε_{ij} are identically and independently distributed across consumers and choices with the extreme value (Weibull) distribution function.

Since the above assumptions place strong restrictions on the substitution patterns, we employ the "nested" multinomial logit model. In this model, the products are grouped into G+1 sets, when the outside good, j=0, is assumed to be the only member of group 0. This classification yields a much more reasonable pattern of substitution among products. As in Verboven (1996), the probability of choosing product j in group g is:

$$s_j = \frac{e^{\delta_j/(1-\sigma)}}{D_g^{\sigma}\left(\sum_g D_g^{1-\sigma}\right)} \tag{2}$$

where

$$\delta_j \equiv x_j\beta - \alpha p_j + \xi_j, \tag{3}$$

is the mean utility level of product j, and

$$D_g = \sum_{j \in G_g} e^{\delta_j/(1-\sigma)}. \tag{4}$$

G_g denotes the set of automobiles of type g, and $0 \le \sigma < 1$ measures the degree of substitution among the products in the classes or groups. If σ=0, the cross elasticities among cars do not depend on the particular classification of the products, resulting in a simple logit model with symmetric competition across cars in the market. When σ is

positive, there is a high substitution between cars that belong to the same group. If σ approaches one, the cross elasticity between any two cars that belong to different group is zero.

The use of the nested multinomial logit model is appropriate when the substitution patterns depend on classes of products determined prior to estimation. In the case of the automobile industry, there is a standard classification system which relates each car to one of the following groups: small, compact, medium, large, luxury/sport, according to its characteristics. Thus, we use the nested logit model to estimate the equilibrium in the Israeli automobile market. As shown in Berry the market shares can be inverted into the following equation:

$$\ln(s_j / s_0) = x_j\beta - \alpha p_j + \sigma \ln(\bar{s}_{j/g}) + \xi_j, \tag{5}$$

where $\bar{s}_{j/g}$ is the share of product j in group g, and s_0 is the proportion of consumers that choose not to purchase a new car, that is chose the outside good. We can obtain the estimates of α, β and σ from an instrumental variable regression.

2.2 Multiproduct Oligopoly Pricing

Following the literature, we assume that the marginal cost of producing each product is independent of the output levels and linear in a vector of cost characteristics. That is the marginal cost of good j is:

$$mc_j = \omega_j \gamma + \upsilon_j, \tag{6}$$

where ω_j is a vector of observable characteristics, υ_j is an unobserved cost characteristic and γ is a vector of unknown parameters. The Israeli automobile market has no domestic production, thus the assumption of constant marginal cost is quite realistic in the case of the Israeli automobile market. The profits of a multiproduct firm f selling F products are:

$$\pi_f = \sum_{k=1}^{F} (p_k / (1+t) - mc_k) q_k, \tag{7}$$

where p_k is the retail price of product k, q_k is the corresponding quantity sold, t is the tax rate, and mc_k is the marginal cost of producing automobile k. Assume that firms compete through prices and that they only take into account the cross elasticities among their products within a group. The derivative of the first order condition can be found in Verboven (1996). Given the marginal cost equation, the first order condition (pricing equation) for product j is:

$$(8) \qquad \frac{p_j}{1+t} = \omega_j \gamma + \frac{(1-\sigma)}{\alpha(1+t)[1-\sigma\sum_{k\in f_g} q_k / Q_g - (1-\sigma)\sum_{k\in f_g} q_k / M} + \upsilon_j,$$

where f_g represents the set of products that firm f is selling in group g, Qg is the total number of sales in group g, and $M = \sum_{i=0}^{N} q_i$. The endogenous of the last term on the right hand side suggests the need of instruments for the estimation of the pricing equation..

3. Estimation

The model to be estimated consists of demand equation (5) and pricing equation (8). We estimate this two equation system using the general method of moments. The estimation method choice was based on three aspects of the system: (i) the unobserved demand characteristics, ξ_j, and the unobserved cost characteristics, υ_j, might be correlated; (ii) α and σ appear in both equations; (iii) the equations are not linear in α and σ.

3.1 Instruments

We need to specify instruments for both the demand and the pricing equations. The endogenous terms we need instruments for are within-group shares, $\bar{s}_{j/g} = q_j / Q_g$, firm shares within a group, $\sum_{k\in G_g} q_k / Q_g$, and prices. Following the literature we take the characteristics of other cars and cost shifters as instruments.

As shown in Bresnahan, Stern and Trajtenberg (1995), the number of other products in a group and the sum of the characteristics of other products in a group are negatively correlated with within-group shares, and therefore can be used as instruments for this variable. As for instruments for firm shares within a group, we can see that this variable is positively correlated with the number of other products the firm sells in the group and with the sum of the characteristics of the other cars it sells in the group. Further, firm shares within a group are negatively correlated with the number of products sold by competitors in the group, and with the sum of characteristics of products sold by competitors in the group. Finally, we will consider instruments for price. The pricing equation suggests that an increase in the number of other automobiles that a firm sells within the group will increase the price. Another important instrument for price is the exchange rate between 1994 and 1995.

Due to multicollinearity, we can only use two of the following variables: (i) the sum of the characteristics of the other products in the group, (ii) the sum of the characteristics of the other products sold by the firm in the group, and (iii) the sum of the characteristics of products sold by other competitors in the group.

3.2 Data

In the Israeli market the luxury/sport class is extremely small, and hence we employ the classes: small, compact, medium and large. Both in 1994 and 1995, the sales of private cars that belongs to these classes were approximately 113,000. In each year, more than 170 different products were available[2]. Restricting the sample to brands that had

[2]Models with different engine size are considered to be different products.

more than 80 sales, there were 213 brands left: 101 models in 1994 and 112 models in 1995.

In Israel, all import licenses are exclusive, and prices are declared by the exclusive dealer. We used Yitzhak Levi pricebook for price data, where prices are in New Israeli Shekels.[3] The Levi pricebook includes the car features;[4] hence for each price observation, we know what additional features were available[5].

The retail price includes taxes of 144 percent on automobiles subject to custom duties, and 128 percent on automobiles not subject to custom duties. Total taxes are composed of three types of taxes: (i) a 95 percent luxury tax on private automobile, (ii) a 17 percent value added tax, (iii) and a 7 percent customs tax. All private automobiles are subject to the luxury and value added tax. Automobiles that are imported from the United States, Canada, and European Countries are exempt from custom duties because of free trade agreements. Automobiles from Japan and South Korea are not exempt from custom duties.

Our data includes the variable ENGINE, which is the engine size in liters, and the dummy variables SMALL, COMPACT, MEDIUM and LARGE, these variables take on the value one if the automobile belongs to one of these classes. The dummy variables AIRCONDITION and AUTOMATIC take on the value one if the model has air conditioning or automatic transmission (respectively). AIRBRAKE takes on the value two if the model has both airbags and ABS brakes system, one if the model has only one of theses features, and zero if it has non of the features.

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[3]The average exchange rate in both 1994 and 1995 was 3.00 New Israeli Shekels = $1.00.

[4]In the Israeli market, many premium features (like dual airbags, automatic transmission, ABS braking system etc.) are included as standard equipment or not available.

The dummy variable YEAR95 takes on the value one if the model was sold in 1995 and zero if the model was sold in 1994. EXCHANGE takes on the value zero if the model was sold in 1994 and equals the percentage change (from 1994 to 1995) in the exchange rate of the manufacture's country currency versus the New Israeli Shekel, if the model was sold in 1995. The dummy variables JAPAN95, KOREA95, USA95, ITALY95 GERMANY95 and FRANCE95 take on the value one if the automobile is both produced in that country and in 1995.

3.3 GMM Estimation

In the estimation we include the variables ENGINE, AIRCONDITION, AUTOMATIC, AIRBRAKE both in the observable demand characteristics, x_j, and the observable cost characteristics, ω_j. Additionally, the cost characteristics vector includes the variables EXCHANGE, YEAR95, JAPAN95, KOREA95, USA95, ITALY95 GERMANY95 and FRANCE95; the demand characteristic vector includes a dummy variable for Japanese and Korean (J&K) compact automobiles.

The instruments we employ are the sum of the engine sizes of the other products in the group, the sum of the engine sizes of the other products that a firm sells in the group, the number of other products in the group, the number of other products that a firm sells in the group, and the change in the average exchange rate between 1994 and 1995. The results of this estimation are shown table 1.

	Both Equations		

[5] In the case in which options are available, we took the model with the fewest options.

Variable	Coefficient	Standard		
$1/\alpha$	53849	13435		
σ	0.51	0.07		
	Demand Equation		Pricing Equation	
Variable	Coefficient	Standard	Coefficient	Standard
CONSTANT	-3.46	0.35	-14481	4625
ENGINE	0.20	0.11	16509	1639
AIRBRAKE	0.04	0.11	7169	982
AUTOMATIC	0.09	0.11	2463	1084
	0.22	0.12	2069	1343
JKCOMPACT	0.94	0.15		
EXCHANGE			1233	629
YEAR95			-2566	3171
GERMANY95			-3033	6935
JAPAN95			-5383	3969
FRANCE95			-7444	5151
USA95			1615	3171
KOREA95			5869	5109
ITALY95			4409	3735
GMM OBJ	7.59 (p value=0.11)			

Table 1: GMM Results

The estimates of the marginal cost of air conditioning and automatic transmission are in line with the option prices that are listed separately in the Levi pricebook. In addition the model predicts that the marginal cost of producing French, German and Japanese automobile increased significantly in 1995 relative to the average 1994 automobile due to increase in the exchange rate. The above results indicate that the model fits the data reasonably well.

4. The Effects of Changes of the Tax Regime.

Given the parameters estimated in the previous section we will now analyze the effects of different tax regimes by simulating the equilibrium of the oligopolistic market equilibrium under different tax and custom regimes.

4.1 Reducing the custom on Japanese and Korean cars.

As we noted before the custom duties are such that the Japanese and the Korean cars are subject to a 144% tax rate (which includes luxury tax, sales tax and customs) while the European and American cars are subject to a 128% tax rate. Our first experiment is to analyze the effect of elimination of customs duties, i.e., imposing a uniform tax rate of 128% for all automobiles imported to Israel.

Eliminating costume duties increases the market size by 2.2%; nevertheless government revenue from taxes decrease by 2.7%. The distribution among the four classes shifts from small cars to compact cars, while the shares of the medium and large classes stay almost the same. Table 2 summarizes the changes in the distribution of automobile sales by groups.

	Small	Compact	Medium	Large	Total
1995 Simulated Distribution	27.2%	47.4%	17%	8.4%	100%
1995 Distribution with Uniform Tax	26.6%	48.1%	17%	8.3%	100%

Table 2: Distribution of Automobile Sales by Group.

Looking at the fraction of Japanese and Korean automobile in each group versus the share of European and American automobiles before the elimination and after it shows unsurprisingly, that there is an increase in JK cars while the share of European and American automobiles in each class decreases. This effect is more dramatic in the Medium and Large classes; there is a 10.5% increase in the JK cars that belong to the Medium category and a 24.5% increase in the JK cars that belong to the Large category. The comparison is shown in table 3:

Small		Compact		Medium		Large	
E+US	JK	E+US	JK	E+US	JK	E+US	JK
-1.3%	+3.3%	-5%	+4.7%	-3.6%	+10.5%	-1.8%	+24.5%

Table 3: The change in shares of European and American automobiles versus Japanese and Korean automobiles within the same group.

The average change in prices differs along the classes, and in each class the average change differs between Japanese and Korean cars and European and American cars. The distribution of average changes in price among the four classes is shown in table 4. From the simulation results, we can see that Japanese and Korean manufacturers would lower prices in the 2.7%-5.1% range, while custom elimination implies a tax reduction of

6.6%[6]. This difference implies that the Japanese and Korean manufacturers pass on part of the tax cut to consumers; this part decreases as the car gets bigger.

Small		Compact		Medium		Large	
E+US	JK	E+US	JK	E+US	JK	E+US	JK
-0.01%	-2.7%	-0.01%	-3.9%	-0.04%	-4.6%	-0.02%	-5.06%

Table 4: Changes in Prices of European and American automobiles versus Japanese and Korean automobiles within the same group.

4.2 Increasing Sales tax by 10% on all cars.

Our next exercise is increasing the luxury tax from 95% to 105% on all cars, such that overall taxes for automobiles subject to custom duties are now 157% and for automobiles exempted from custom duties overall taxes are 140%.

Simulating the new market with the above taxes reveals a reduction in the number of cars sold in Israel: an increase of 10% in luxury tax reduces the market's size by 3.15%.

The increase in overall taxes increases prices of all cars, and therefore encourages consumers to buy smaller cars. The leftward shift of consumers towards cars that belong to the small class can be seen in Table 5, which shows the distribution of car sales among the groups.

[6] The tax burden/relaxation is calculated such that the manufacturer price p/(1+t) is the same before and after the tax change.

	Small	Compact	Medium	Large	Total
1995 Simulated Distribution	27.2%	47.4%	17%	8.4%	100%
1995 Distribution with 10% Increase	27.7%	47.5%	16.8%	8%	100%

Table 5: Distribution of Automobile Sales by Group.

Most models suffer from a large decrease in sales as a result of the tax increase. Nevertheless, some models had an increase in their sales. The sales of Fiat Uno and Fiat Punto, for example, increased, despite the fact that there prices increased. This is a result of the consumers' shift towards small cars and the low marginal cost of Fiat models in the small class.

The average increase in prices in the small class was 2.65%, while the average increase in prices in the Large class was 4.17%. This can be explained by the fact that before the increase in taxes, the average price cost margin in the small class was 22%, while this average in the large class was 9%. Hence firms selling in the small class lower primarily lower their price cost margin instead of increasing prices. An increase of 10% luxury taxes causes an increased tax burden of 5.2%. Increasing prices less than 5.2% means that manufacturers incurred some of the increase in tax burden.

Although prices increased, there was a 63 Million NIS decrease in consumer expenditure on private automobiles due to the reduction in market's size and the leftward shift to smaller (and cheaper) cars. Comparing government revenues from taxes reveals

that in spite of the fact that manufacturer's price and the market's size have decreased, the tax increase led to a 2.8% increase in government revenues.

4.3 Decreasing Sales Tax by 30% on all cars.

Our last exercise is a tax reform which decreases the luxury tax by 30%. As a result of this reform, overall taxes for automobiles subject to costume duties are 107%, while overall taxes for automobiles exempted from costume duties are 93%.

The results of simulating the new market reveals that such an increase in tax expands the markets size by 9.7%; there is a rightward shift towards bigger automobiles, since these cars are now less expensive. The car sales distribution is summarized in table 6.

	Small	Compact	Medium	Large	Total
1995 Simulated Distribution	27.2%	47.4%	17%	8.4%	100%
1995 Distribution with 30% Decrease	25.8%	46.8%	17.6%	9.8%	100%

Table 6: Distribution of Automobile Sales by Group.

A 30% reduction in the luxury tax reduces the tax burden by 15.3%. The simulation shows that the average decrease in automobiles prices in the Small class is 7.5%, while the average decrease in automobiles prices in the Large class is 12.1%. As before, this suggests that the tax relaxation is divided between consumers and manufacturers, reducing government revenues from taxes in 11.6%.

5. Concluding Remarks

This paper discusses the effect of different tax regimes on the Israeli automobile market; in our belief, the main contribution of this paper is the approach it uses. While there is an extensive literature on the effect of taxation on the product market, to the best of our knowledge, none of the papers in the literature employs structural estimation in order to simulate the post tax market. As we demonstrated in this paper, such a procedure may provide new insight in particular when analyzing a differentiated product oligopoly. In such industries taxation affects the profile of goods which are produced and consumed as well as relative prices.

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