Estimating the effect of tax reform in differentiated product oligopolistic markets

Fershtman, C.; Gandal, N.; Markovich, S.

Publication date:
1998

Citation for published version (APA):
Fershtman, C., Gandal, N., & Markovich, S. (1998). *Estimating the effect of tax reform in differentiated product oligopolistic markets*. (CentER Discussion Paper; Vol. 1998-34). CentER.

entER
for
omic Research

Discussion paper

[redacted]

Tilburg University

Center
for
Economic Research

No. 9834

ESTIMATING THE EFFECT OF TAX REFORM IN DIFFERENTIATED PRODUCT OLIGOPOLISTIC MARKETS

By Chaim Fershtman, Neil Gandal and
Sarit Markovich

March 1

ISSN 0924-7815

Estimating the Effect of Tax Reform in Differentiated Product Oligopolistic Markets

by

Chaim Fershtman, Neil Gandal,* and Sarit Markovich

Tel Aviv University

March 1998

Abstract

The incidence of taxation and the design of an optimal tax system have been extensively discussed in the public finance literature but mainly within a competitive market setting or within a homogenous good (Cournot type) oligopoly. In a differentiated product oligopoly, the effect of taxation can be more complex as the rate of taxation may affect not only the prices, but also the profile, as well as the quality of products that are sold in the market. In this paper, we develop a methodology for examining the effects of different taxation regimes in a differentiated product oligopoly. In order to demonstrate the methodology and the effects discussed above, we examine one such market: the automobile market in Israel. Our approach involves two steps. We first estimate the Nash equilibrium in a differentiated product oligopoly and then use the results to simulate the new equilibrium under different tax regimes. Using the estimated parameters from the current market equilibrium, we examine the effect of changes in the tax and custom regimes on (i) the quantities sold in the market, (ii) market prices, (iii) firms' profits, (iv) government revenues and (v) the types of cars sold in the market.

Keywords: Taxation, Differentiated Product Oligopoly

JEL: H2,L8

We are grateful to the Sapir Center for Development for Financial Support and to seminar participants at Haifa University, Tel Aviv University, the University of Texas, and the 1997 EARIE Conference in Louvain for helpful comments.

*Corresponding Author. Dept. of Public Policy, Tel Aviv University, 69978 Tel Aviv, ISRAEL. Tel: 972 3 640 6742, Fax: 972 3 640 7382, E-mail:gandal@econ.tau.ac.il

Introduction:

The incidence of taxation and the design of an optimal tax system have been extensively discussed in the Public Finance literature; most of the work on this subject has been conducted within the framework of a competitive market or within the framework of a homogenous good oligopoly characterized by Cournot competition. Auerbach (1985) provides a good theoretical survey on commodity taxation in competitive markets. Katz and Rosen (1985), Myles (1987), and Stern (1987) examine commodity taxation issues such as tax design, optimal taxes and tax incidence in oligopolies in which firms compete on quantities and sell homogeneous products. In this paper we examine, both theoretically and empirically, the issues of tax reform in a very relevant market: oligopoly markets in which firms sell differentiated products.

In an oligopoly, in which products are differentiated both horizontally and vertically, the effect of taxation may be complex since the tax regime may affect not only the prices, but also the profile and quality of the products that each firm sells.

In order to illustrate the complex effect of taxation on a 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 in that they differ in size, quality, features etc. At any given point in time these firms compete in prices. The price vector determines how many cars of each model are sold. In determining the price for a specific model, each firm must take into account competition from other firms as well as the effect of the price of a particular model on its other models. Now assume that a tax is imposed. This will change the market equilibrium and will affect not just the prices of cars but also the equilibrium distribution of cars that each firm sells. In particular, it is possible that a uniform increase in the tax rate, while reducing overall sales in the market and overall sales of a particular firm, may increase sales of particular model. Such an effect will occur if, for example, as a result of the tax increase there is a shift in sales to smaller cars.

This paper examines taxation issues in an oligopolistic market with horizontally and vertically differentiated products in which firms (may) sell multiple brands. While we apply our framework to the automobile market in Israel, the type of analysis we employ is applicable to other differentiated product oligopolies. The paper investigates the effect of changes in the taxation regime on equilibrium prices, the size and composition of the market, consumer surplus, government tax revenues, and firm profits.

In our analysis, we employ recent advances in estimating discrete-choice models of product differentiation. These techniques, developed by Berry (1994) and Berry, Levinsohn, and Pakes (1995), enable structural estimation of both the demand and oligopoly pricing aspects that characterize differentiated products. The model of oligopolistic competition that we employ is based on Berry (1994) and is similar to the one used by Verboven (1996) and the one used in our previous work (Fershtman and Gandal (1998)).[1] We use the model and data on prices, quantities, and characteristics for 1994 and 1995 (the latest years for which the data are available) 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 such regimes. Currently the retail price in Israel includes three types of taxes (a luxury tax, a value-added tax, and custom duties). Total taxes are 144 percent on automobiles subject to custom duties (automobiles manufactured in Japan and Korea) , and 128 percent on automobiles not subject to custom duties (automobiles manufactured in the United States or European countries). We investigate the effect of three possible tax reforms that are, or were, under consideration in Israel. The first reform makes taxation uniform (at 128 percent) for all producers by eliminating custom duties.[2] The second reform is an increase in taxes so that there is a 145% uniform tax rate, while the third reform is a reduction in the tax rate so that the uniform tax rate is 100% . We analyze the effect of these taxation regimes on the number of cars sold in the market, the distribution of types and models of cars sold in the market, prices, and market shares of different manufacturers, as well as on government tax revenues, and firm profits.

We are aware of two purely theoretical papers that examine the effect of taxation in differentiated product oligopolies. Gruenspecht (1988) considers the effect of export subsidies in an oligopoly in which firms sell horizontally differentiated products and compete on prices. In his model, price reductions do not bring new customers into the market; they only lead to market diversion from other competitors. Our setting explicitly allows for both effects and we measure them. Cremer and Thisse (1994) examine the effect of commodity taxation in a setting in which firms sell vertically differentiated products and compete on prices. They show that an increase in taxes reduces the quality of the products that oligopolists will provide. Although we assume that the brands offered are fixed in the short run, our empirical results indeed show that, in the spirit of

---

[1] In Fershtman and Gandal (1998), we examined the effect of the Arab economic boycott on the Israeli automobile industry and estimated the peace dividend (in this industry) associated with the elimination of the boycott.

Cremer and Thisse (1994), increases in taxes lead to a shift in the distribution of sales to smaller and lower quality cars.

Empirical work in the literature has almost exclusively been conducted under the assumption that the relevant industry is competitive. Kenkel (1996) examines the optimal rate of taxation on alcohol. In his setting, he assumes that there is a single "alcoholic" product that is priced at marginal cost. He acknowledges that the "alcoholic beverage industry is probably better described as oligopolistic, but the implications for tax incidence are unclear" (Kenkel (1996) p. 300). Our methodology allows examination of tax incidence in differentiated product oligopolies.

To the best of our knowledge, Barnett, Keeler, and Hu (1995) is the only paper that employs an oligopoly model to examine the effect of taxation. Using a Cournot model with homogeneous products to model competition among manufacturers in the cigarette industry, they examine the incidence of cigarette taxes. Using the estimated parameters, they simulate the effect of changes in the rate of cigarette taxation. Given that there is not a great deal of vertical differentiation among the popular cigarette brands, the homogeneous Cournot model is probably a reasonable model to use in their setting. In the automobile market in Israel, the price among the available models ranges in 1995 from $14,833 for a Fiat Uno (a 1.1 Liter engine with a standard transmission and no air-conditioning) to $64,987 for a Volvo 960 (a 3.0 liter engine, air-conditioning, automatic transmission, airbags, ABS brakes, and other premium features). Clearly, we cannot model competition in this industry by employing a Cournot model with homogeneous products.

---

[2] Since Israel has signed the latest round of the GATT, custom duties in this market will eventually have to be eliminated.

2. The Oligopolistic Model

We model the automobile industry as an oligopolistic market with N multiproduct firms. Short run competition among the firms is through prices. Market demand is determined by aggregating a discrete choice model of consumer behavior.

2.1 Demand

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

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

where x_j is a vector of observed product characteristics (such as engine size) and p_j is the price of automobile j. α and β are parameters to be estimated. The last two terms of (1) are error terms: ξ_j is the average value of product j's unobserved characteristics (and is the same for all consumers) and ε_{ij} represents the distribution of consumer preferences around this mean. The term ε_{ij} introduces heterogeneity and its distribution determines the substitution patterns among products. Under the assumption that the ε_{ij} are identically and independently distributed across consumers and products with the extreme value (Weibull) distribution function, the probability of choosing product j (the market share of product j) is given by:

(2) $$s_j = \frac{e^{\delta_j}}{\left(\sum_k e^{\delta_k}\right)},$$

where

(3) $$\delta_j \equiv x_j\beta - \alpha p_j + \xi_j,$$

is the mean utility level from product j. It is well known that this "logit" distribution yields unreasonable substitution patterns among products;[3] it is commonly used because it yields a closed form solution for the market share of each product.

In order to overcome the unreasonable substitution patterns, similar to other authors, we employ the "nested" multinomial logit model. Goldberg (1995) and Verboven (1996) also employ variants of the nested logit model in their studies of the automobile industry. This structure yields a much more reasonable pattern of substitution among products.

As Berry (1994) notes, the nested logit is appropriate when the substitution effects among products depend primarily on predetermined classes of products. This assumption seems reasonable in the case of automobiles; indeed industry groups employ a standard classification system that puts each car in one of the following groups: subcompact, compact, midsize, large, and luxury/sport, according to its characteristics.

In the nested logit model, the products are grouped into G+1 sets, where the outside good, j=0, is assumed to be the only member of group 0. The difference between the logit and the nested logit is that there is an additional variable, denoted ζ, which is

---

[3] For more on general extreme value (GEV) models, see McFadden (1978).

common to all products in group g and has a distribution that depends on σ, $0 \leq \sigma < 1$. In the case of the nested logit model, the utility of consumer i from product j is $u_{ij} = \delta_j + \zeta_{ij} + (1-\sigma)\varepsilon_{ij}$, where $\delta_j \equiv x_j\beta - \alpha p_j + \xi_j$ is again the mean utility level and $\zeta + (1-\sigma)\varepsilon$ also has an extreme value (Weibull) distribution. In this case, the probability of choosing product j in group g is:

(4)
$$s_j = \frac{e^{\delta_j/(1-\sigma)}}{D_g^{\sigma}\left(\sum_g D_g^{1-\sigma}\right)}$$

where $D_g = \sum_{[j \in G_g]} e^{\delta_j/(1-\sigma)}$, G_g denotes the set of automobiles of type g, and $0 \leq \sigma < 1$ is an additional parameter to be estimated; it measures the degree of substitution among the products in the classes or groups. If σ=0, the cross elasticities among products do not depend on the classification; in this case, the simple multinomial logit model (Eq. (1)) is appropriate. When σ>0, there is a higher degree of substitution among cars that belong to the same group than among cars from different groups. If σ approaches one, the cross elasticity between any two cars that belong to different groups approaches zero.

We use the nested logit model to estimate the equilibrium in the Israeli automobile market. As shown in Berry (1994), Eq. (4) can be inverted to yield the following equation:

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

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, the proportion of consumers that choose the outside good. Following the literature, we assume that the size of the potential market is known; s_0 is then the difference between the size of the potential market and the actual market. Since the price and the group share are endogenous, we can obtain consistent estimates of α, β and σ from an instrumental variable regression.

2.2 Multiproduct Oligopoly Pricing

We assume that the marginal cost of producing each product is independent of the output levels and linear in a vector of cost characteristics. The assumption of constant marginal cost is typically employed in the relevant literature. Moreover, since the Israeli automobile market is small compared to the world market, the assumption of constant marginal cost is quite realistic in this case. The marginal cost of good j is:

(6) $$mc_j = \omega_j \gamma + \upsilon_j ,$$

where ω_j is a vector of observable characteristics, υ_j is an unobserved cost characteristic and γ is a vector of unknown parameters to be estimated.

The operating profits of a multiproduct firm f selling F different types of automobiles are:

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

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.

We assume that firms compete through prices and that they only take into account the cross elasticities among their products within a group. It can be shown (with a lot of tedious algebra - see Verboven (1996)) - that the first order condition (pricing equation) for product j is:

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

where f_g represents the set of products that firm f is selling in group g, Q_g is the total number of sales in group g, and $M = \sum_{i=0}^{N} q_i$. The last term on the right hand side is endogenous, suggesting that instrumental variables are also needed in order to estimate the pricing equation.

3. Estimation

The model to be estimated consists of the demand and the pricing equations (Eqs. (5) and (8) respectively). We estimate this two equation system using the general method of moments (GMM). We chose to employ GMM estimation for the following reasons: (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 for which we need instruments are product shares within a group ($\bar{s}_{j/g} \equiv q_j / Q_g$), firm shares within a group, ($\sum_{k \in G_g} q_k / Q_g$), and prices. We use the characteristics of other cars and cost shifters as instruments.

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. Now consider firm shares within a group. 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 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. An important additional instrument for price is the change in the exchange rate between 1994 and 1995.[4]

3.2 Data

In the Israeli market the luxury/sport class is extremely small (due to the relatively high rate of taxation); hence we employ the classes: subcompact, compact, midsize and large. Approximately 113,000 automobiles were sold in both 1994 and 1995. More than

170 different products were available in each year.[5] Restricting the sample to brands that had more than 80 sales, left 213 brands: 101 models in 1994 and 112 models in 1995.

In Israel, all import licenses are exclusive, and the exclusive dealer sets prices. We used the Levi price book for price data, where prices are in New Israeli Shekels.[6] The Levi price book, which is the most popular price book in Israel, includes the car features;[7] hence for each price observation, we know what additional features were available[8].

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 the following three components: (i) a 95 percent luxury tax on private automobiles, (ii) a 17 percent value added tax and (iii) a 7 percent customs tax; the taxes are cumulative. All private automobiles are subject to the luxury and value added tax. Automobiles that are produced and 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 SUBCOMPACT, COMPACT, MIDSIZE 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

---

[4] Of course, all of the instruments are valid for all of the endogenous variables; we discuss the instruments in this manner so that we can provide the economic intuition behind the choice of instruments.

[5] Models with different engine size are different products.

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

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

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

two if the model has both airbags and ABS brakes system, one if the model has only one of these features, and zero if it has none of the features.

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 manufacturer'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 for 1995 automobiles that are produced in the relevant country. (These countries account for 85 percent of the automobiles sold in Israel in 1994-1995.) Descriptive statistics for these variables are shown in tables A and B in the appendix.

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 country dummy variables are included solely to examine the change in the marginal cost of production for each country from 1994 to 1995. (Country dummies for 1994 would have no meaning since EXCHANGE takes on the value zero if the model is sold in 1994.) The estimated coefficients associated with the other variables are virtually unchanged if we exclude the country dummy variables. The demand characteristic vector includes a dummy variable for compact automobiles (denoted COMPACT); this variable is included because this class of vehicles is especially popular.

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 exchange rate between 1994 and 1995. The results of the GMM estimation are shown table 1.

	Both Equations			
Parameter	Coefficient	Standard Error		
α	2.1×10^{-5}	8.6×10^{-6}		
σ	0.70	0.07		
	Demand Equation		Pricing Equation	
Variable	Coefficient	Standard Error	Coefficient	Standard Error
CONSTANT	-2.56	0.34	-5849	3449
ENGINE	0.13	0.15	14517	1663
AIRBRAKE	0.15	0.09	7467	1045
AUTOMATIC	0.15	0.08	3463	1349
AIRCONDITIO	0.19	0.09	2203	1081
COMPACT	0.72	0.09		
EXCHANGE			640	48
YEAR95			-2293	3452
GERMANY95			47	8340
JAPAN95			-1182	4806
FRANCE95			-1648	6199
USA95			1893	4426
KOREA95			3204	5700
ITALY95			3423	4140
GMM OBJ	16.61			

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 price book (Recall that the prices are in New Israeli Shekels.) In addition the model predicts that the marginal cost of producing French, German and Japanese automobiles increased significantly in 1995 relative to the typical 1994 automobile; these increases were primarily due to significant appreciation of the French, German, and Japanese currencies against the New Israeli Shekel. The estimated elasticities of demand also seem quite plausible: the average (sales weighted) elasticity of demand is –3.53 for the subcompact class, -4.70 for the compact class, -5.62 for the midsize class, and –9.15 for the large class.

The model also predicts that similar to the U.S., there is some market power in the Israeli automobile market: the average (sales weighted) price-cost margin is 10 percent. This is slightly lower than the price-cost margins obtained by BLP (1995) for the U.S. automobile industry.

4. The Effects of Changes in 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 Eliminating Custom Duties on Japanese and Korean cars.

As we noted before the custom duties in Israel are such that the Japanese and the Korean (J&K) cars are subject to a 144% tax rate, which includes luxury tax, value added (sales) tax and customs; European and American cars are subject to a 128% tax rate. Our first experiment is to analyze the effect of eliminating customs duties, i.e., imposing a uniform tax rate of 128% for all automobiles imported to Israel. Since Israel is now a signatory to the GATT, it suggests that the custom duties will be eliminated in the near future.

Our market simulation indicates that eliminating custom duties increases the market size by 2.3%, while government revenues from taxes decrease by 1.8%. The distribution among the four classes shifts from subcompact cars to compact cars, while the shares of the midsize and large classes stay almost the same. (This is because J&K automobiles make up a very large portion of the compact class. See table B in the appendix). Table 2 summarizes the changes in the distribution of automobile sales by groups.

	Subcompact	Compact	Midsize	Large	Total
1995 Simulated Distribution	26.7%	46.2%	17.6%	9.5%	100%
1995 Distribution: Uniform 128% Tax	26.2%	46.7%	17.7%	9.4%	100%

Table 2: Distribution of Automobile Sales by Group.

The elimination of the custom tax leads to an increase in the share of J&K automobiles in each class while the share of European and American (E&US) decreases. Custom elimination implies a 6.6% reduction in the tax burden (for Japanese and Korean vehicles), where we define the tax burden to be the percentage change in prices such that the dealer price p/(1+t) is unchanged before and after the tax change. The simulation shows that Japanese and Korean firms would lower prices in the 4.1%-5.8% range, following the elimination of custom duties. This implies that part of the tax reduction is passed onto consumers. The consumers' share of the tax reduction is higher in the larger classes.

The elimination of custom duties has a significant effect on the profits of the different firms. The profits of American and European manufacturers fall by 4-10 percent, while the profits of the Japanese and Korean firms rise by anywhere from 20-33 percent. Honda has the largest increase in profits (33%); this is because their models are in the midsize and large classes. Thus despite the fact that the distribution of sales among classes does not change significantly (Table 2), the distribution of sales (and profits) within classes changes significantly.

Table 5 summarizes the effects of eliminating customs duties:

Changes following the elimination of custom duties	actual change	% change
Size of the Market	+2,408	+2.3
Total Spending (Millions $)	+4.6	+0.19
Tax Revenues (Millions $)	-25	-1.8
Total Firms' Profits (Millions $)	+11.5	+5.1

Table 5

4.2 Increasing the Luxury Tax so that there is a 145% Uniform Tax .

Our next exercise is increasing the luxury tax so that there is a 145% uniform tax on all automobiles. Simulating the new market equilibrium shows that there would be a 5.8% reduction in the number of cars sold in Israel, relative to the number of cars that would be sold under a 128% uniform tax. 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 subcompact class can be seen in Table 6, which shows the distribution of car sales among the groups.

	Subcompact	Compact	Midsize	Large	Total
1995 Distribution: 128% Uniform	26.2%	46.7%	17.7%	9.4%	100%
1995 Distribution: 145% Uniform	26.9%	46.8%	17.4%	9.0%	100%

Table 6: Distribution of Automobile Sales by Group.

Most models would have lower sales at a tax rate of 145% than at a tax rate of 128%. Nevertheless, some models would have an increase in their sales. The sales of Fiat Uno and Fiat Punto, for example, would increase, despite the fact that their prices would have increased. This is a result of the consumers' shift to small cars.

The simulation predicts that there would be a 47$ Million decrease in consumer spending on automobiles as a result of the tax increase. This manifests itself in a reduction in the market's size and a leftward shift to smaller (and cheaper) cars. Despite the decrease in market size, the increase in the luxury tax results in a 3.4% increase in government revenues. These results are summarized in Table 7.

Changes following the increase in the luxury tax	Actual changes	% change
Size of the Market	-6277	-5.8
Total Spending (Millions $)	-47	-1.9
Tax Revenues (Millions $)	+47	+3.4
Total Firms' Profits (Millions $)	-29	-12.2

Table 7.

4.3 Decreasing Taxes so that there is a 100% Uniform Tax on all Cars.

Our next exercise is a tax reform that decreases the luxury tax so that there is a 100% uniform tax on all cars. This increase in the tax rate expands the markets size by 10.4% relative to a 128% uniform tax; there is a rightward shift towards larger automobiles, since these cars are now relatively less expensive. The simulated sales distribution is summarized in table 8.

	Subcompact	Compact	Midsize	Large	Total
1995 Distribution: 128% Uniform Tax	26.2%	46.7%	17.7%	9.4%	100%
1995 Distribution: 100% Uniform Tax	25.1%	46.2%	18.1%	10.5%	100%

Table 8: Distribution of Automobile Sales by Group.

The reduction in the luxury taxes reduces the tax burden by 12.3%. Government revenues from taxes fall by 8.7% following the decrease in the luxury tax, while firms' profits increase by 25.5%. Table 9 summarizes these results.

Changes following the decrease in the luxury tax	Actual changes	% change
Size of the Market	+11,169	+10.4
Total Spending (Millions $)	+61.8	+2.5
Tax Revenues (Millions $)	-120	-8.7
Total Firms' Profits (Millions $)	+60.3	+25.5

Table 9.

5. The Effect of the Tax Rate on Tax Revenues, Market size, etc.

In this section, we simulate the equilibrium for uniform tax rates in the 100%-160% range and calculate the associated tax revenues. Figure 1 shows how the tax revenues by class change over the range of tax rates.

Figure 2 shows how firms' profits change as the tax rate increases from 100% to 160%. The profile of the automobiles sold in the market would likely be different at the lower end of the range than at the higher end of the tax range. An examination of individual models shows that the number of Buick LeSabres, Chrysler Visions and Volvo 960s fall by more than 70% as the tax rate increases to 160%. These are among the largest and most expensive models available in the Israeli market today. If the tax rate did increase to 160%, it is likely that these models would not be available in Israel.

In figure 3, we graph the market size (for each group) as a function of the tax rate. An increase in the tax rate from 100% to 160% percent reduces the market size by 19%; more importantly, it significantly shifts the distribution of sales to the subcompact and compact categories. Such an increase in the tax rate significantly reduces sales of large automobiles: its sales fall by 36%. The size of the midsize class also falls significantly (by 23.2%). The size of the subcompact and compact class declines by much less: 17.8% for the compact class and 11.3 percent for the subcompact class.

6. Concluding Remarks

While the paper examines the effect of different tax regimes on the Israeli automobile market, the main contribution of this paper is the methodology it employs. As we demonstrated, our framework provides a methodology for examining the effects of changes in tax regimes in differentiated product oligopolies. As we have shown, in such industries taxation affects the profile of goods that are sold as well as relative prices in a way that depends on the elasticity of demand of all products and the degree of competition in the market.

The methodology we developed provides regulators with an instrument to predict the effect of different tax policies not only on tax revenues and the number of cars that are sold in the market, but also on the distribution of the type of automobiles that are sold; hence different tax regimes can be evaluated and compared for their effect on the average engine size (which determines the consumption of fuel), the percentage of automobiles that offer safety features (such as Airbags and ABS brakes), as well as the level of imports.

References

Auerbach, A., "The theory of Excess Burden and Optimal Taxation," in A. Auerbach and M. Feldstein, eds., Handbook of Public Economics. Vol. 1 Amsterdam: North-Holland, 1985.

Barnett, P., Keeler, T., and T. Hu, "Oligopoly Structure and the Incidence of Cigarette Excise Taxes, Journal of Public Economics, 57 (1995): 457-470.

Berry, Steven "Estimating Discrete-Choice Models of Product Differentiation," Rand Journal of Economics, 25 (1994): 334-347.

Berry, S., J. Levinsohn, and A. Pakes, Automobile Prices in Market Equilibrium", Econometrica 63 (1995): 841-890.

Cremer, H. and J. F. Thisse, "Commodity Taxation in Differentiated Oligopoly" International Economic Review 35 (1994): 613-633.

Fershtman, C., and N. Gandal, "The Effect of the Arab Boycott on Israel: The Automobile Market", RAND Journal of Economics: 29 (1998): 193-214.

Goldberg, P., "Product Differentiation and Oligopoly in International Markets: The Case of the U.S. Automobile Industry," Econometrica, 63 (1995): 891-952.

Gruenspecht, H., "Export Subsidies for Differentiated Products," Journal of International Economics, 24 (1988): 331-344.

Katz, M., and H. Rosen, "Tax Analysis in an Oligopoly Model," Public Finance Quarterly 13 (1985): 3-19.

Kenkel, D., "New Estimates of the Optimal Tax on Alcohol," Economic Inquiry, 34 (1996): 296-319.

McFadden, D., "Modeling the Choice of Residential Location," In A. Karlquist et al., eds., Spacial Interaction Theory and Planning Models. Amsterdam: North Holland, 1978.

Myles, G., "Tax Design in the Presence of Imperfect Competition: An Example," Journal of Public Economics 34 (1987): 36-378.

Stern, N., "The Effects of Taxation, Price Control and Government Contracts in Oligopoly and Monopolistic Competition," Journal of Public Economics 32 (1987): 133-158.

Verboven, F., "International Price Discrimination in the European Car Market", RAND Journal of Economics 27 (1996): 240-268.

Figure 1: Tax Revenues by Group as Function of Tax Rate

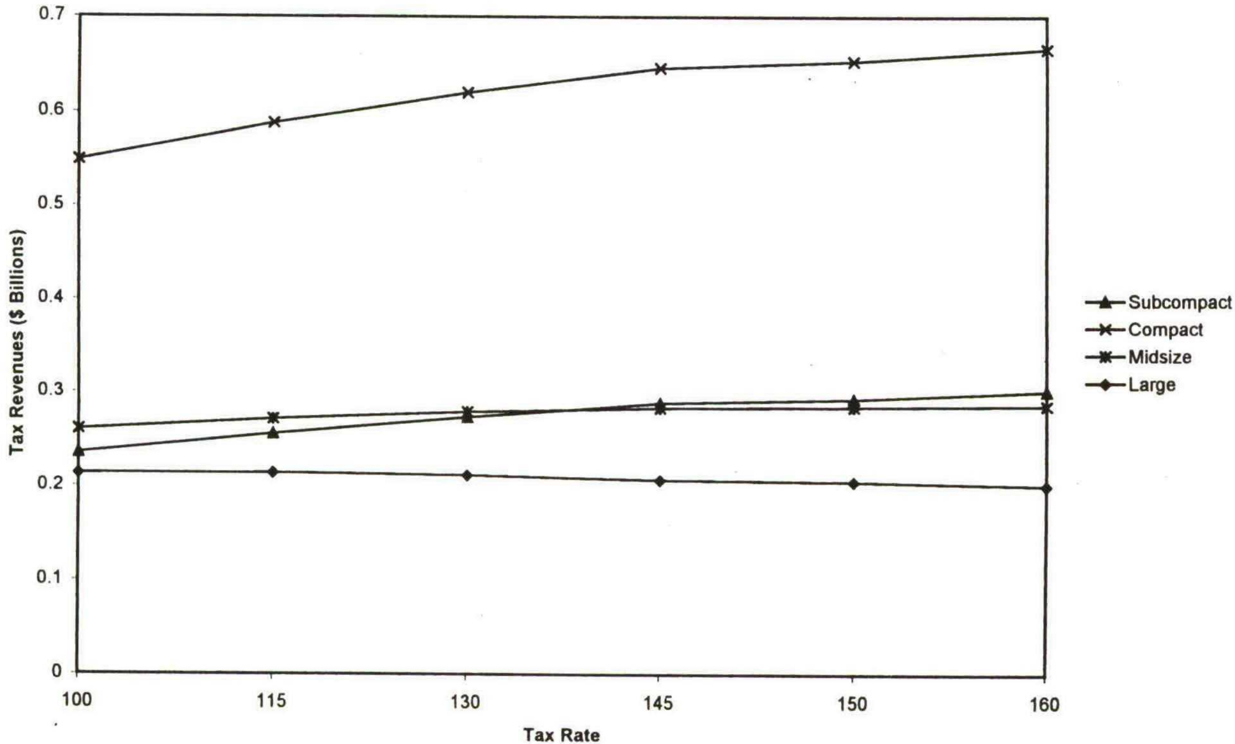


Figure 2: Firms' Profits as a Function of the Tax Rate

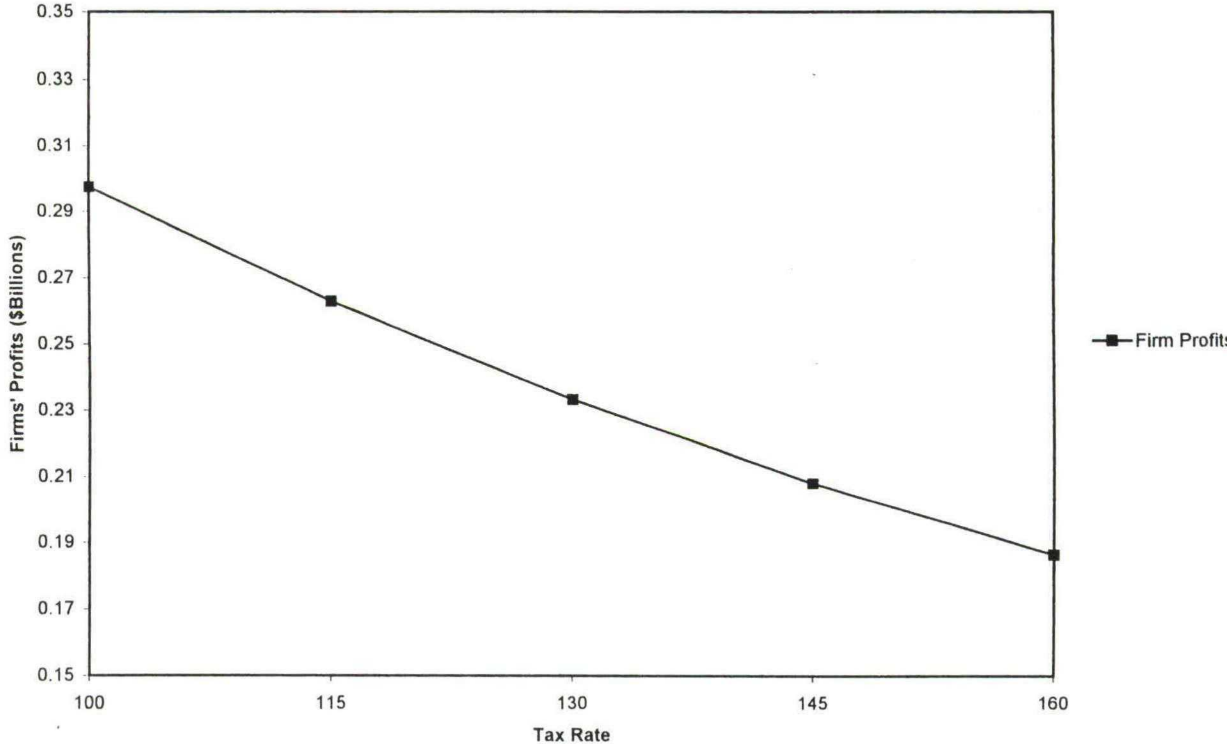
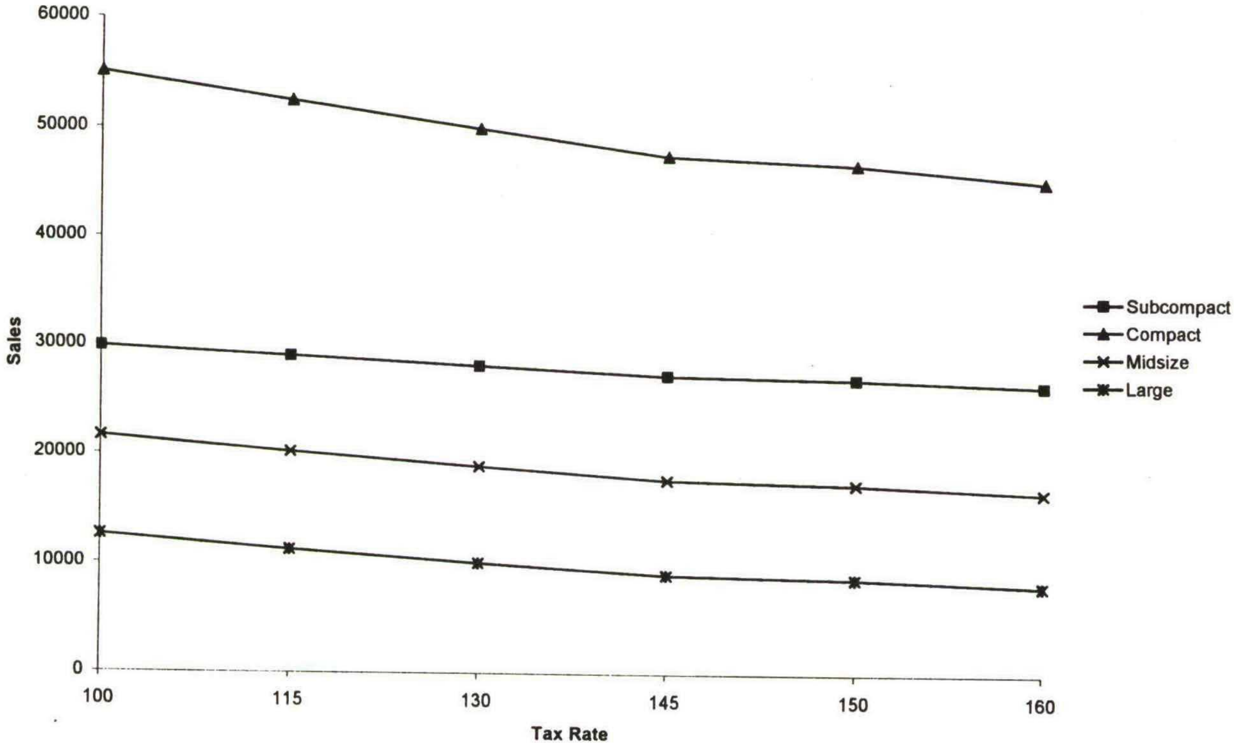


Figure 3: Sales by Class as a Function of the Tax Rate



Variable	Mean	Maximum	Minimum
PRICE	68481	194962	29999
QUANTITY	1044	11447	80
ENGINE	1.63	3.8	1.00
AIRCONDITION	0.88	1.00	0.00
AUTOMATIC	0.21	1.00	0.00
AIRBAGS	0.12	1.00	0.00
ABS BRAKES	0.07	1.00	0.00
SMALL	0.25	1.00	0.00
COMPACT	0.52	1.00	0.00
MEDIUM	0.16	1.00	0.00
LARGE	0.07	1.00	0.00
JAPAN	0.34	1.00	0.00
KOREA	0.16	1.00	0.00
FRANCE	0.13	1.00	0.00
ITALY	0.12	1.00	0.00
USA	0.07	1.00	0.00
GERMANY	0.04	1.00	0.00
EXCHANGE	4.91	13	-3
YEAR95	0.50	1.00	0.00

Table A: Descriptive Statistics

	Small	Compact	Medium	Large	Total
1994 Total Sales	25026	58075	19004	9087	111192
1994 Models	19	37	20	25	101
1994 J & K Sales	3733	36773	13031	1579	55116
1994 J & K Models	5	11	10	6	32
1994 "Boycott" Sales	1240	28848	12206	1579	43873
1994 "Boycott" Models	1	8	8	6	23
1995 Total Sales	31155	57129	15381	7614	111279
1995 Models	33	33	27	19	112
1995 J & K Sales	2241	47763	4744	891	55639
1995 J & K Models	6	16	12	2	36
1995 "Boycott" Sales	1467	41945	4497	891	48800
1995 "Boycott" Models	2	13	11	2	28

Table B: Automobile Sales by Group.

No.	Author(s)	Title
9759	R.M.W.J. Beetsma and H. Uhlig	An Analysis of the "Stability Pact"
9760	M. Lettau and H. Uhlig	Preferences, Consumption Smoothing, and Risk Premia
9761	F. Janssen and T. de Kok	The Optimal Number of Suppliers in an (s,Q) Inventory System with Order Splitting
9762	F. Janssen and T. de Kok	The Fill Rate Service Measure in an (s,Q) Inventory System with Order Splitting
9763	E. Canton	Fiscal Policy in a Stochastic Model of Endogenous Growth
9764	R. Euwals	Hours Constraints within and between Jobs
9765	A. Blume	Fast Learning in Organizations
9766	A. Blume	Information Transmission and Preference Similarity
9767	B. van der Genugten	Canonical Partitions in the Restricted Linear Model
9768	W. Güth and B. Peleg	When Will the Fittest Survive? -An Indirect Evolutionary Analysis-
9769	E. Rebers, R. Beetsma and H. Peters	When to Fire Bad Managers: The Role of Collusion Between Management and Board of Directors
9770	B. Donkers and A. van Soest	Subjective Measures of Household Preferences and Financial Decisions
9771	K. Kultti	Scale Returns of a Random Matching Model
9772	H. Huizinga and S.B. Nielsen	A Welfare Comparison of International Tax Regimes with Cross-Ownership of Firms
9773	H. Huizinga and S.B. Nielsen	The Taxation of Interest in Europe: A Minimum Withholding Tax?
9774	E. Charlier	Equivalence Scales for the Former West Germany
9775	M. Berliant and T. ten Raa	Increasing Returns and Perfect Competition: The Role of Land
9776	A. Kalwij, R. Alessie and P. Fontein	Household Commodity Demand and Demographics in the Netherlands: a Microeconometric Analysis
9777	P.J.J. Herings	Two Simple Proofs of the Feasibility of the Linear Tracing Procedure
9778	G. Gürkan, A.Y. Özge and S.M. Robinson	Sample-Path Solutions for Simulation Optimization Problems and Stochastic Variational Inequalities
9779	S. Smulders	Should Environmental Standards be Tighter if Technological Change is Endogenous?

No.	Author(s)	Title
9780	B.J. Heijdra and L. Meijdam	Public Investment in a Small Open Economy
9781	E.G.F. Stancanelli	Do the Rich Stay Unemployed Longer? An Empirical Study for the UK
9782	J.C. Engwerda and R.C. Douven	Local Strong *d*-Monotonicity of the Kalai-Smorodinsky and Nash Bargaining Solution
9783	J.C. Engwerda	Computational Aspects of the Open-Loop Nash Equilibrium in Linear Quadratic Games
9784	J.C. Engwerda, B. van Aarle J.E.J. Plasmans	The (In)Finite Horizon Open-Loop Nash LQ-Game: An Application to EMU
9785	J. Osiewalski, G. Koop and M.F.J. Steel	A Stochastic Frontier Analysis of Output Level and Growth in Poland and Western Economies
9786	F. de Jong	Time-Series and Cross-Section Information in Affine Term Structure Models
9787	G. Gürkan, A.Y. Özge and S.M. Robinson	Sample-Path Solution of Stochastic Variational Inequalities
9788	A.N. Banerjee	Sensitivity of Univariate AR(1) Time-Series Forecasts Near the Unit Root
9789	G. Brennan, W. Güth and H. Kliemt	Trust in the Shadow of the Courts
9790	A.N. Banerjee and J.R. Magnus	On the Sensitivity of the usual *t*- and *F*-tests to AR(1) misspecification
9791	A. Cukierman and M. Tommasi	When does it take a Nixon to go to China?
9792	A. Cukierman, P. Rodriguez and S.B. Webb	Central Bank Autonomy and Exchange Rate Regimes - Their Effects on Monetary Accommodation and Activism
9793	B.G.C. Dellaert, M. Prodigalidad and J.J. Louvriere	Family Members' Projections of Each Other's Preference and Influence: A Two-Stage Conjoint Approach
9794	B. Dellaert, T. Arentze, M. Bierlaire, A. Borgers and H. Timmermans	Investigating Consumers' Tendency to Combine Multiple Shopping Purposes and Destinations
9795	A. Belke and D. Gros	Estimating the Costs and Benefits of EMU: The Impact of External Shocks on Labour Markets
9796	H. Daniëls, B. Kamp and W. Verkooijen	Application of Neural Networks to House Pricing and Bond Rating
9797	G. Gürkan	Simulation Optimization of Buffer Allocations in Production

No.	Author(s)	Title
		Lines with Unreliable Machines
9798	V. Bhaskar and E. van Damme	Moral Hazard and Private Monitoring
9799	F. Palomino	Relative Performance Equilibrium in Financial Markets
97100	G. Gürkan and A.Y. Özge	Functional Properties of Throughput in Tandem Lines with Unreliable Servers and Finite Buffers
97101	E.G.A. Gaury, J.P.C. Kleijnen and H. Pierreval	Configuring a Pull Production-Control Strategy Through a Generic Model
97102	F.A. de Roon, Th.E. Nijman and C. Veld	Analyzing Specification Errors in Models for Futures Risk Premia with Hedging Pressure
97103	M. Berg, R. Brekelmans and A. De Waegenaere	Budget Setting Strategies for the Company's Divisions
97104	C. Fernández and M.F.J. Steel	Reference Priors for Non-Normal Two-Sample Problems
97105	C. Fernández and M.F.J. Steel	Reference Priors for the General Location-Scale Model
97106	M.C.W. Janssen and E. Maasland	On the Unique D1 Equilibrium in the Stackelberg Model with asymmetric information
97107	A. Belke and M. Göcke	Multiple Equilibria in German Employment -Simultaneous Identification of Structural Breaks-
97108	D. Bergemann and U. Hege	Venture Capital Financing, Moral Hazard, and Learning
97109	U. Hege and P. Viala	Contentious Contracts
97110	P.J.-J. Herings	A Note on "Stability of Tâtonnement Processes of Short Period Equilibria with Rational Expectations"
97111	C. Fernández, E. Ley, and M.F.J. Steel	Statistical Modeling of Fishing Activities in the North Atlantic
97112	J.J.A. Moors	A Critical Evaluation of Mangat's Two-Step Procedure in Randomized Response
97113	J.J.A. Moors, B.B. van der Genugten, and L.W.G. Strijbosch	Repeated Audit Controls
97114	X. Gong and A. van Soest	Family Structure and Female Labour Supply in Mexico City
97115	A. Blume, D.V. DeJong, Y.-G. Kim and G.B. Sprinkle	Evolution of Communication with Partial Common Interest
97116	J.P.C. Kleijnen and R.G. Sargent	A Methodology for Fitting and Validating Metamodels in Simulation

No.	Author(s)	Title
97117	J. Boone	Technological Progress and Unemployment
97118	A. Prat	Campaign Advertising and Voter Welfare
9801	H. Gersbach and H. Uhlig	Debt Contracts, Collapse and Regulation as Competition Phenomena
9802	P. Peretto and S. Smulders	Specialization, Knowledge Dilution, and Scale Effects in an IO-based Growth Model
9803	K.J.M. Huisman and P.M. Kort	A Further Analysis on Strategic Timing of Adoption of New Technologies under Uncertainty
9804	P.J.-J. Herings and A. van den Elzen	Computation of the Nash Equilibrium Selected by the Tracing Procedure in *N*-Person Games
9805	P.J.-J. Herings and J.H. Drèze	Continua of Underemployment Equilibria
9806	M. Koster	Multi-Service Serial Cost Sharing: A Characterization of the Moulin-Shenker Rule
9807	F.A. de Roon, Th.E. Nijman and B.J.M. Werker	Testing for Mean-Variance Spanning with Short Sales Constraints and Transaction Costs: The Case of Emerging Markets
9808	R.M.W.J. Beetsma and P.C. Schotman	Measuring Risk Attitudes in a Natural Experiment: Data from the Television Game Show Lingo
9809	M. Bütler	The Choice between Pension Reform Options
9810	L. Bettendorf and F. Verboven	Competition on the Dutch Coffee Market
9811	E. Schaling, M. Hoeberichts and S. Eijffinger	Incentive Contracts for Central Bankers under Uncertainty: Walsh-Svensson non-Equivalence Revisited
9812	M. Slikker	Average Convexity in Communication Situations
9813	T. van de Klundert and S. Smulders	Capital Mobility and Catching Up in a Two-Country, Two-Sector Model of Endogenous Growth
9814	A.Belke and D. Gros	Evidence on the Costs of Intra-European Exchange Rate Variability
9815	J.P.C. Kleijnen and O. Pala	Maximizing the Simulation Output: a Competition
9816	C. Dustmann, N. Rajah and A. van Soest	School Quality, Exam Performance, and Career Choice
9817	H. Hamers, F. Klijn and J. Suijs	On the Balancedness of *m*-Sequencing Games
9818	S.J. Koopman and J. Durbin	Fast Filtering and Smoothing for Multivariate State Space Models

No.	Author(s)	Title
9819	E. Droste, M. Kosfeld and M. Voorneveld	Regret Equilibria in Games
9820	M. Slikker	A Note on Link Formation
9821	M. Koster, E. Molina, Y. Sprumont and S. Tijs	Core Representations of the Standard Fixed Tree Game
9822	J.P.C. Kleijnen	Validation of Simulation, With and Without Real Data
9823	M. Kosfeld	Rumours and Markets
9824	F. Karaesmen, F. van der Duyn Schouten and L.N. van Wassen-hove	Dedication versus Flexibility in Field Service Operations
9825	J. Suijs, A. De Waegenaere and P. Borm	Optimal Design of Pension Funds: A Mission Impossible
9826	U.Gneezy and W. Güth	On Competing Rewards Standards -An Experimental Study of Ultimatum Bargaining-
9827	M. Dufwenberg and U. Gneezy	Price Competition and Market Concentration: An Experimental Study
9828	A. Blume, D.V. De Jong and G.R. Neumann	Learning in Sender-Receiver Games
9829	B.G.C. Dellaert, J.D. Brazell and J.J. Louviere	Variations in Consumer Choice Consistency: The Case of Attribute-Level Driven Shifts in Consistency
9830	B.G.C. Dellaert, A.W.J. Borgers, J.J. Louviere and H.J.P. Timmermans	Consumer Choice of Modularized Products: A Conjoint choice Experiment Approach
9831	E.G.A. Gaury, H. Pierreval and J.P.C. Kleijnen	New Species of Hybrid Pull Systems
9832	S.J. Koopman and H.N. Lai	Modelling Bid-Ask Spreads in Competitive Dealership Markets
9833	F. Klijn, M. Slikker, S. Tijs and J. Zarzuelo	Characterizations of the Egalitarian Solution for Convex Games
9834	C. Fershtman, N. Gandal and S. Markovich	Estimating the Effect of Tax Reform in Differentiated Product Oligopolistic Markets