MIXED OLIGOPOLIES AND THE PROVISION OF DURABLE GOODS

by

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Abstract

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This paper studies models in which socially concerned firm is present on the durable goods market and competes with a private or another socially concerned firm. We compare results of these models with investigated earlier pure duopoly case, when only private firms are present on the market. The previous results for the pure duopoly case show the presence of Prisoners' Dilemma. In such situation every firm prefers selling to renting, but (renting, renting) outcome gives more profit for each firm than (selling, selling) one. We consider 2 models: in the first one socially concerned firm competes with private firm and in the second one 2 socially concerned firms are competing. We received that in both cases Prisoners' Dilemma still determines behavior of market participants. Therefore the attitude of the firm towards social welfare is not crucial in making renting/selling decisions.

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INTRODUCTION

Coase (1972) was the first one to notice that a monopoly selling a durable good has different behaviour from another one selling a non-durable good.
In his seminal paper he showed that due to its profit-maximizing behaviour a monopoly firm prefers renting the durable good to selling it. The simple explanation of it corresponds to the assumption of consumers' rational expectations. Consumers predict that a monopoly selling durable goods would face smaller potential market size in the next periods and therefore will be forced to decrease prices. These expectations reduce the price that consumers are ready to pay in the first period when the monopoly offers the product for sale. Due to the latter demand for durable good falls. As a consequence, the monopoly would be forced to set up price for the durable good close to marginal cost (the Coase conjecture). Later, Bulow (1982) showed the firms might prefer to decrease the durability of their product.

Poddar (2004) raised the following question: "How does the situation change when durable goods market moves from monopoly to oligopoly?" He considered a pure duopoly market structure (two private firms are competing) in a durable goods market.
In his paper he shows that mentioned above competition leads to some kind of Prisoners' Dilemma: selling is a preferred action for both firms, but in this equilibrium firms make lower profits comparing to the situation when both firms are renting. This finding can partially explain co-existence of selling and renting strategies on the market.

But not only pure oligopolies case is present on the market. In many countries private firms have to compete with public non-profit firms. Oil industry and manufacturing are the typical examples of so-called mixed oligopolies. In recent years non-profit organizations (NPO) have become more active and moved into traditionally commercial markets. Case (2005) stressed that these NPOs have got billions in revenues and actively continue to grow.

Currently, NPOs are not very actively present on durable goods market.
But Benz (2005) claimed that NPOs should be very successful in the hi-tech industries, in which durable output is produced.
In my thesis I am trying to answer the following question: "What will be the consequences of more active participation of socially concerned firms on durable good markets?" The impact of their presence and behaviour on the renting/selling decisions of private firms is also investigated.

The remainder of the paper is organized in the following way. The literature review is presented in Chapter 2. Chapter 3 provides methodology and model setup. The mixed duopoly case, when private firm competes with the socially concerned one is examined in chapter 4. Competition of 2 socially concerned firms is investigated in chapter 5. Finally, the paper is summarized, and concluding remarks are made in Chapter 6.

Chapter 2

LITERATURE REVIEW

In his seminal paper Coase (1972) showed that for durable goods monopolist renting is more profitable than selling. The main reason behind it is that in the case of selling durable good is used by customer in the following periods, therefore decreasing demand that monopolist faces. As a consequence, monopolist is forced to decrease price and profit from the next periods. Moreover, from the hypothesis of rational expectations (RE hypothesis) consumers are willing to pay less even in the first period. As a result monopolist loses a substantial part of its profits in the selling case.

Bulow (1982, 1986) investigated the case when monopoly firm cannot convince customers that it will not change prices when demand falls. In this case the selling monopolist chooses smaller durability for goods than those produced by renting monopolists. This situation, in which goods are produced with inadequately short lives to force buyers to repeat purchases, is called 'Planned Obsolescence'.

Bucovetsky and Hilton (1986) investigated the case when durable goods monopolist is faced with some threat of entry. They showed that in contrast to pure case when monopolist prefers renting under new circumstances it will choose some kind of mixed strategy: both selling and renting. Kuhn and Padilla (1996) considered the situation when durable good monopolist is also present on non-durable goods market, demand for which is strongly correlated with demand for durable goods. They made a conclusion that presence of a competitor on non-durable goods market increases willingness to sell for monopolist on the durable goods market.

The other reason why monopolists prefer selling is the discrimination in quality. Kumar (2002) investigated the case when monopoly can discriminate consumers and provide high-demand and low-demand buyers with different packages of quality of product and prices. In case of resale, trading monopolist will try to increase quality of production over time. This behaviour stimulates highly sophisticated consumers to buy products with the highest quality available and resale it to less sophisticated consumers as soon as new quality of production is available. Moreover, it does not even imply that the price of the product goes up over time. Kumar (2002) shows that prices can be even decreased in the future.

In real world, pure monopoly case is not the most frequent one. As a consequence other market structures were analysed. Saggi and Vettas (2000) investigated pure duopoly case, when 2 firms are doing both activities (selling and renting) in each period. Their main result was that renting to selling ratio is determined by values of production costs. For a particular firm an increase in production costs implies increase in renting/selling ratio.

Poddar (2004) considered pure duopoly structure for 2-period model. He showed that for every firm selling is preferred to renting although (renting, renting) gives higher profits than (selling, selling) for them. This finding can help partly explain the fact that selling is dominating on the durable goods market in the real world.

Another possible situation on the market is the case when private firm is competing with non-profit socially concerned firm. The capacity choice in such mixed oligopolies was investigated by Lu and Poddar (2005). They showed that on the non-durable goods market the private firm chooses overproduction while public firm chooses underproduction. Lu and Poddar (2006) investigated the case of uncertainty in demand. They showed that public firm might also prefer to choose excess capacity in such conditions. Ogawa (2006) considered influence of different product differentiation. He showed that in case when products produced by firms are complements both firms choose to oversupply.

Goering (2006) analysed a simple linear demand 2-period durable goods for the case where only non-profit organization is present on the market. He showed that socially optimal (here it is equivalent to cost minimizing) durability would be provided by NPO in case of renting. Also he proved that a NPO seller would not provide this durability if it had no commitment power with buyers. Moreover, in such case NPO seller is producing a less durable good than profit-maximizing firm. Also he claimed that a mixed oligopoly model fits better for exploring the impact of NPO. He assumed that a full comparison of social impacts of NPOs would likely to lead to interesting although complicated results.

To sum up, only case of pure duopoly, when 2 private firms are competing, was investigated for the durable goods market. In this thesis we are investigating 2 other cases. The first one arises when a private firm competes with a socially concerned firm within the 2-period durable goods framework. The second case we consider is a competition of 2 equally socially concerned firms. We are trying to investigate whether Prisoners' dilemma, which is described by Poddar (2004) for the pure duopoly case, still is present for highly mentioned market situations. We prove that it still exists, and we can conclude that situation on durable goods duopoly is not strongly affected by firms' attitude to social welfare. Therefore, in such case the following conclusion can be made. If monopoly is present on the market monopolist chooses renting strategy, which is not socially optimal. But if new firm enters the market its attitude to social welfare does not play important role: (selling, selling) is the only Nash equilibrium, although (renting, renting) gives higher profits for both firms. Therefore the factor of competition is more important here than attitude of firms to social welfare.

Chapter 3

METHODOLOGY

Consider a market in which consumers have different reservation prices for some durable good. Suppose that consumers live for two periods.

The good does not depreciate from the first to the second period. Also we assume that secondhand market does not exist, so consumers that buy product in the first period cannot resell it in the second period. Producers face linear demand curve. At period 1 the aggregate demand of consumers is given by $p(Q) = a - Q$, where p is the price of the good at period 1, and Q is the aggregate supply of this good.

We consider two types of actions: renting and selling. In our model, we should distinguish between renting and selling in the first period only. If a consumer buys a good in the first period he will also use it during the second period. Since the last one is the end of consumers' lifetime both actions (renting and selling) are equivalent.

Now consider firms' behaviour. Suppose two firms are producing the same durable good. We consider case when private firm competes with socially concerned firm in Chapter 4, while case when both firms are socially concerned is analysed in Chapter 5.

Assume both firms have zero production costs. Although the case of non-zero costs can also be considered, as our purpose is to determine the influence of market structure on production and renting vs. selling decisions this kind of specification is appropriate.

Consider model of Cournot competition where firms are competing in quantities and due to the latter ones the market price is determined.

Further, we consider that game between firms is going in the following way (in the way of describing a game I follow Poddar (2004), who considered the similar case, but for private firms only).
Before making decisions of how much good to produce in the first period firms should decide simultaneously which action renting or selling to choose. This might be considered as a pre-play stage.

After decision was made firms choose quantities in periods 1 and 2 with the purpose of maximizing its own profit functions, which will be introduced further. As we noted earlier, the choice of actions matters only for the first period since the second period is the end of lifetime.

Now describe the specific "profit" functions, which both firms are trying to maximize. The goal of private firm is to maximize its own total profits gained in periods 1 and 2. On the contrary, the goal of SC firm is to maximize the sum of its own total profits and consumers' surplus, discounted by factor $\theta (0 \le \theta < 1)$ (but it does not care about other private firm). Factor θ shows interest of SC firm in the welfare of society: $\theta = 0$ corresponds to case of pure private firm, if θ is close to 1 we can interpret it as SC firm cares about society almost in the same way as about its own profits.

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COMPETITION BETWEEN A PRIVATE FIRM AND A SOCIALLY CONCERNED ONE

In this chapter we investigate competition between private firm and socially concerned firm, the goal of the latter one is to maximize the sum of its own total profits and total consumers' surplus, discounted by factor θ.

We start solving the game by the method of backward induction. In this game, in the pre-play period 4 scenarios may occur:

1. Both firms decide to rent
2. Private firm rents and NPO sells
3. Private firm sells and NPO rents
4. Both firms decide to sell.

We investigate each of these 4 cases (subgames) separately while solving this game.

Case 1. Renting/Renting

In case of renting/renting consumers are obligated to return goods after the first period. Therefore, in the second period firms face the same demand curve as in the first period. As a result we can investigate 1-period case and it will be sufficient to receive the answer for it.

Let x - amount of good that 1st (private) firm produces,

y - amount of good that 2nd (SC) firm .

Then price for the good is determined from the linear demand curve $p(Q) = a - Q$, where Q is the aggregate supply. Therefore $p = a - x - y$.

Profit functions for the firms are determined as the following:

$\pi_{\mathrm{Pr}ivate} = \pi_1 = x(a - x - y)$

$\pi_{NPO} = \pi_2 = y(a - x - y) + \theta * CS$, where CS is consumer surplus.

For the linear demand curve:

$$CS = \int_{a-x-y}^{a} (v - p)dv = \frac{1}{2}(x + y)^2 .$$

Therefore $\pi_{NPO} = \pi_2 = y(a - x - y) + \theta * 0.5(x + y)^2$.

Write down first-order conditions to determine Nash equilibrium of this subgame:

$$\begin{cases} \dfrac{\partial \pi_1}{\partial x} = a - y - 2x = 0 \\ \dfrac{\partial \pi_2}{\partial y} = a - x - 2y + \theta(x + y) = 0 \end{cases}$$

Solving this system we receive:

$$\begin{cases} x = \dfrac{1-\theta}{3-\theta} a \leq \dfrac{1}{3} a \\ y = \dfrac{1+\theta}{3-\theta} a \geq \dfrac{1}{3} a \end{cases}$$

$$x + y = \frac{2}{3-\theta} a \geq \frac{2}{3} a$$

$$p = a - x - y = \frac{1-\theta}{3-\theta} a \leq \frac{1}{3} a$$

Therefore we come to the following conclusion.

Proposition 1. Comparing with the pure duopoly case in 1-period game, in mixed duopoly case private firm underproduces ($x \le \frac{1}{3}a$), whereas NPO overproduces ($y \ge \frac{1}{3}a$). Total production increases ($x + y \ge \frac{2}{3}a$), while the price naturally becomes lower ($p \le \frac{1}{3}a$).

Substituting obtained x and y into consumers' surplus profit functions we obtain:

$$CS^R = \frac{1}{2}(x+y)^2 = \frac{2}{(3-\theta)^2}$$

$$\pi_1^R = px = \left(\frac{1-\theta}{3-\theta}\right)^2 a^2$$

$$\pi_2^R = py + \theta * CS^R = \frac{1+2\theta-\theta^2}{(3-\theta)^2} a^2$$

Taking into account that renting/renting case is equivalent to 2 sequential 1-period games we receive:

$\pi_1^{RR} = 2\pi_1^R = 2\left(\frac{1-\theta}{3-\theta}\right)^2 a^2 \le \frac{2}{9}a^2$ (private firm receives less profit comparing to the case when it competes with another private firm)

$$\pi_2^{RR} = 2\pi_2^{RR} = \frac{2(1+2\theta-\theta^2)}{(3-\theta)^2} a^2$$

$$CS^{RR} = 2CS^R = \frac{4}{(3-\theta)^2}$$

Case 2. Renting/Selling

Let x_1 - amount of good that 1st (private) firm rents in the first period,

y_1 - amount of good that 2nd (SC) firm sells in the first period.

x_2 - amount of good that 1st (private) firm sells in the second period,

y_2 - amount of good that 2nd (SC) firm produces in the second period.

Let's use backward induction to analyze this case.

In the second period both firms face the following demand curve $p(Q) = a - y_1 - Q$ (as y_1 units were already sold in the first period).

Therefore, as was shown in renting/renting case firms choose the following quantities in the second period:

$$x_2 = \frac{1-\theta}{3-\theta}(a - y_1) \qquad y_2 = \frac{1+\theta}{3-\theta}(a - y_1)$$

Price, which is set up by firms in the second period:

$$p_2 = \frac{1-\theta}{3-\theta}(a - y_1)$$

Then profits received by firms in the second period are given by the following formulas:

$$CS_{(2)}^{RS} = \frac{2}{(3-\theta)^2}(a - y_1)^2$$

$$\pi_1^{(2)} = p_2 x_2 = \left(\frac{1-\theta}{3-\theta}\right)^2 (a - y_1)^2$$

$$\pi_2^{(2)} = \frac{(1+2\theta-\theta^2)}{(3-\theta)^2}(a - y_1)^2$$

Now move back to the first period. For this very period both renting and selling are present, there are 2 prices on the market: price for selling p_1^S and price for renting p_1^R.

The necessary condition for co-existence of both activities: $p_1^S = p_1^R + p_2$

(otherwise all consumers prefer one activity to another).

The second one is the condition for marginal consumer, which is indifferent between buying in the first period at a higher price, then using the good during second period and buying it in the second period at a lower price:

$$2[a - x_1 - y_1] - p_1^S = a - x_1 - y_1 - p_2$$

From these conditions we obtain that:

$$p_1^R = a - x_1 - y_1$$

$$p_1^S = \frac{4-2\theta}{3-\theta}(a - y_1) - x_1$$

Substituting received prices into profit functions we get:

$$\pi_1 = p_1^R x_1 + \pi_1^{(2)} = x_1(a - x_1 - y_1) + \left(\frac{1-\theta}{3-\theta}\right)^2 (a - y_1)^2$$

$$\pi_2 = p_1^S y_1 + \theta * CS_1 + \pi_2^{(2)}$$

Consumer surplus when both renting and selling are present

$$CS_{(1)}^{RS} = \int_{a-y_1}^{a} (2v - p_1^S)dv + \int_{a-y_1-x_1}^{a-y_1} (v - p_1^R)dv = \int_{a-y_1-x_1}^{a} (v - p_1^R)dv + \int_{a-y_1}^{a} (v - p_2)dv =$$

$$= \frac{1}{2}(x_1 + y_1)^2 + \frac{2}{3-\theta}(a - y_1)y_1 + \frac{1}{2}y_1^2$$

Then

$$\pi_2 = p_1^S y_1 + \theta * CS_1 + \pi_2^{(2)} = y_1[\frac{4-2\theta}{3-\theta}(a - y_1) - x_1] + \theta * (\frac{1}{2}(x_1 + y_1)^2 +$$

$$+ \frac{2}{3-\theta}(a - y_1)y_1 + \frac{1}{2}y_1^2) + \frac{(1 + 2\theta - \theta^2)}{(3-\theta)^2}(a - y_1)^2$$

Write down first-order conditions to determine Nash equilibrium of this subgame:

$$\begin{cases} \dfrac{\partial \pi_1}{\partial x_1} = a - y - 2x = 0 \\ \dfrac{\partial \pi_2}{\partial y_1} = \dfrac{4-2\theta}{3-\theta}(a-2y_1) - x_1 + \theta\left[(x_1+y_1) + \dfrac{2}{3-\theta}(a-2y_1) + y_1 \right] - \\ -\dfrac{2(1+2\theta-\theta^2)}{(3-\theta)^2}(a-y_1) = 0 \end{cases}$$

Solving this system we receive:

$$\begin{cases} x_1 = \dfrac{12-22\theta+12\theta^2-2\theta^3}{35-45\theta+21\theta^2-3\theta^3}a \\ y_1 = \dfrac{11-\theta-3\theta^2+\theta^3}{35-45\theta+21\theta^2-3\theta^3}a \end{cases}$$

Plugging these values we receive the following results:

$$x_2 = \frac{4(2-\theta)(1-\theta)^2}{35-45\theta+21\theta^2-3\theta^3}a \qquad y_2 = \frac{4(2-\theta)(1-\theta)(1+\theta)}{35-45\theta+21\theta^2-3\theta^3}a$$

$$p_2 = \frac{4(2-\theta)(1-\theta)^2}{35-45\theta+21\theta^2-3\theta^3}a \qquad p_1^R = \frac{12-22\theta+12\theta^2-2\theta^3}{35-45\theta+21\theta^2-3\theta^3}a$$

$$p_1^S = \frac{2(2-\theta)(5-3\theta)(1-\theta)}{35-45\theta+21\theta^2-3\theta^3}a$$

Substituting received prices into profit functions we get:

$$CS^{RS} = CS_{(1)}^{RS} + CS_{(2)}^{RS} = \frac{1}{2}(x_1+y_1)^2 + \frac{2}{3-\theta}y_1(a-y_1) + \frac{1}{2}y_1^2 + \frac{2}{(3-\theta)^2}(a-y_1)^2 =$$

$$= \frac{629-1204\theta+919\theta^2-328\theta^3+51\theta^4-4\theta^5+\theta^6}{(35-45\theta+21\theta^2-3\theta^3)^2}$$

$$\pi_1^{RS} = \frac{4(13-14\theta+5\theta^2)(2-\theta)^2(1-\theta)^2}{(35-45\theta+21\theta^2-3\theta^3)^2}a^2$$

$$\pi_2^{RS} = \frac{284-45\theta-770\theta^2+1067\theta^3-640\theta^4+193\theta^5-26\theta^6+\theta^7}{(35-45\theta+21\theta^2-3\theta^3)^2}a^2$$

Case 3. Selling/Renting

Let x_1 - amount of good that 1st (private) firm sells in the first period,

y_1 - amount of good that 2nd (SC) firm rents in the first period.

x_2 - amount of good that 1st (private) firm sells in the second period,

y_2 - amount of good that 2nd (SC) firm sells in the second period.

Let's use backward induction to analyze this case.

In the second period both firms face the following demand curve $p(Q) = a - x_1 - Q$ (as x_1 units were already sold in the first period).

Therefore, as was shown in renting/renting case firms choose the following quantities in the second period:

$$x_2 = \frac{1-\theta}{3-\theta}(a - x_1) \qquad\qquad y_2 = \frac{1+\theta}{3-\theta}(a - x_1)$$

Price, which is set up in the second period:

$$p_2 = \frac{1-\theta}{3-\theta}(a - x_1)$$

Then profits received by firms in the second period are given by the following formulas:

$$CS_{(2)}^{RS} = \frac{2}{(3-\theta)^2}(a - x_1)^2$$

$$\pi_1^{(2)} = p_2 x_2 = \left(\frac{1-\theta}{3-\theta}\right)^2 (a - x_1)^2 \qquad\qquad \pi_2^{(2)} = \frac{(1+2\theta-\theta^2)}{(3-\theta)^2}(a - x_1)^2$$

Now move back to the first period. As during this period both renting and selling are present, there are 2 prices on the market: price for selling p_1^S and price for renting p_1^R.

By full analogy with renting/selling case we obtain that:

$$p_1^R = a - x_1 - y_1$$

$$p_1^S = \frac{4-2\theta}{3-\theta}(a - x_1) - y_1$$

Substituting received prices into profit functions we get:

$$\pi_1 = p_1^S x_1 + \pi_1^{(2)} = x_1[\frac{4-2\theta}{3-\theta}(a-x_1) - y_1] + \left(\frac{1-\theta}{3-\theta}\right)^2 (a-x_1)^2$$

$$\pi_2 = p_1^R y_1 + \theta * CS_{(1)}^{RS} + \pi_2^{(2)} = y_1[a - y_1 - x_1] + \theta(\frac{1}{2}(x_1+y_1)^2 + \frac{2}{3-\theta}(a-x_1)x_1 +$$

$$+\frac{1}{2}x_1^2) + \frac{(1+2\theta-\theta^2)}{(3-\theta)^2}(a-x_1)^2$$

Write down first-order conditions to determine Nash equilibrium of this subgame:

$$\begin{cases} \dfrac{\partial \pi_1}{\partial x_1} = \dfrac{4-2\theta}{3-\theta}(a-2x_1) - y_1 - \dfrac{2(1-\theta)^2}{(3-\theta)^2}(a-x_1) = 0 \\ \dfrac{\partial \pi_2}{\partial y_1} = a - x_1 - 2y_1 + \theta(x_1+y_1) = 0 \end{cases}$$

Solving this system we receive:

$$\begin{cases} x_1 = \dfrac{(1-\theta)(11-5\theta)}{35-39\theta+13\theta^2-\theta^3}a \\ y_1 = \dfrac{12-4\theta^2}{35-39\theta+13\theta^2-\theta^3}a \end{cases}$$

Plugging these values we receive the following results:

$$x_2 = \frac{(1-\theta)(8-5\theta+\theta^2)}{35-39\theta+13\theta^2-\theta^3}a \qquad y_2 = \frac{(1+\theta)(8-5\theta+\theta^2)}{35-39\theta+13\theta^2-\theta^3}a$$

$$p_2 = \frac{(1-\theta)(8-5\theta+\theta^2)}{35-39\theta+13\theta^2-\theta^3}a \qquad p_1^R = \frac{(1-\theta)(12-11\theta+\theta^2)}{35-39\theta+13\theta^2-\theta^3}a$$

$$p_1^S = \frac{2(1-\theta)(10-8\theta+\theta^2)}{35-39\theta+13\theta^2-\theta^3}a$$

Substituting received prices into profit functions we get:

$$CS^{SR}=CS^{SR}_{(1)}+CS^{SR}_{(2)}=\frac{1}{2}(x_1+y_1)^2+\frac{2}{3-\theta}x_1(a-x_1)+\frac{1}{2}x_1^2+\frac{2}{(3-\theta)^2}(a-x_1)^2=$$

$$=\frac{629-1070\theta+678\theta^2-198\theta^3+25\theta^4}{(35-39\theta+13\theta^2-\theta^3)^2}$$

$$\pi_1^{SR}=\frac{(142-107\theta+18\theta^2-\theta^3)(2-\theta)(1-\theta)^2}{(35-39\theta+13\theta^2-\theta^3)^2}a^2$$

$$\pi_2^{SR}=\frac{208+273\theta-997\theta^2+828\theta^3-286\theta^4+39\theta^5-\theta^6}{(35-39\theta+13\theta^2-\theta^3)^2}a^2$$

Case 4. Selling/Selling

Let x_1 - amount of good that 1st (private) firm sells in the first period,

y_1 - amount of good that 2nd (SC) firm sells in the first period.

x_2 - amount of good that 1st (private) firm sells in the second period,

y_2 - amount of good that 2nd (SC) firm sells in the second period.

Let's use backward induction to analyze this case.

In the second period both firms face the following demand curve $p(Q)=a-x_1-y_1-Q$ (as x_1+y_1 units were already sold in the first period).

Therefore, as was shown in renting/renting case firms choose the following quantities in the second period:

$$x_2=\frac{1-\theta}{3-\theta}(a-x_1-y_1)$$

$$y_2=\frac{1+\theta}{3-\theta}(a-x_1-y_1)$$

Price, which is set up by firms in the second period:

$$p_2 = \frac{1-\theta}{3-\theta}(a - x_1 - y_1)$$

Then profits received by firms in the second period are given by the following formulas:

$$CS^{SS}_{(2)} = \frac{2}{(3-\theta)^2}(a - x_1 - y_1)^2$$

$$\pi_1^{(2)} = p_2 x_2 = \left(\frac{1-\theta}{3-\theta}\right)^2 (a - x_1 - y_1)^2$$

$$\pi_2^{(2)} = \frac{(1+2\theta-\theta^2)}{(3-\theta)^2}(a - x_1 - y_1)^2$$

Now move back to the first period. Marginal consumer should be indifferent between buying good at a higher price in the first period, then using it for both periods and buying good at a lower price in the second period:

$$2(a - x_1 - y_1) - p_1 = (a - x_1 - y_1) - p_2$$

Therefore

$$p_1 = \frac{4-2\theta}{3-\theta}(a - x_1 - y_1)$$

Substituting prices into profit functions, we receive:

$$\pi_1 = p_1 x_1 + p_2 x_2 = \frac{4-2\theta}{3-\theta}(a - x_1 - y_1)x_1 + \left(\frac{1-\theta}{3-\theta}\right)^2 (a - x_1 - y_1)^2$$

$$\pi_2 = p_1 y_1 + p_2 y_2 + \theta * CS^{SS}_{(1)} = \frac{4-2\theta}{3-\theta}(a - x_1 - y_1)y_1 + \frac{1+2\theta-\theta^2}{(3-\theta)^2}(a - x_1 - y_1)^2 +$$

$$+\theta * (x_1 + y_1)[\frac{2}{3-\theta}a + \frac{1-\theta}{3-\theta}(x_1 + y_1)]$$

Write down first-order conditions to determine Nash equilibrium of this subgame:

$$
\begin{cases}
\dfrac{\partial \pi_1}{\partial x_1} = \dfrac{4-2\theta}{3-\theta}(a-2x_1-y_1) - \dfrac{2(1-\theta)^2}{(3-\theta)^2}(a-x_1-y_1) = 0 \\
\dfrac{\partial \pi_2}{\partial y_1} = \dfrac{4-2\theta}{3-\theta}(a-2y_1-x_1) + \theta\left[\dfrac{2}{3-\theta}a + 2\dfrac{1-\theta}{3-\theta}(x_1+y_1)\right] - \\
-\dfrac{2(1+2\theta-\theta^2)}{(3-\theta)^2}(a-x_1-y_1) = 0
\end{cases}
$$

Solving this system we receive:

$$
\begin{cases}
x_1 = \dfrac{(1-\theta)(5-3\theta)}{16-18\theta+7\theta^2-\theta^3}a \\
y_1 = \dfrac{5+\theta-2\theta^2}{16-18\theta+7\theta^2-\theta^3}a
\end{cases}
$$

Plugging these values we receive the following results:

$$
x_2 = \frac{(1-\theta)^2}{8-5\theta+\theta^2} \qquad y_2 = \frac{(1-\theta)(1+\theta)}{8-5\theta+\theta^2}
$$

$$
p_2 = \frac{(1-\theta)^2}{8-5\theta+\theta^2} \qquad p_1 = \frac{2(1-\theta)(2-\theta)}{8-5\theta+\theta^2}
$$

Substituting received prices into profit functions we get:

$$
CS^{SS} = CS^{SS}_{(1)} + CS^{SS}_{(2)} = (x_1+y_1)[\frac{2}{3-\theta}a + \frac{1-\theta}{3-\theta}(x_1+y_1)] + \frac{2}{(3-\theta)^2}(a-x_1-y_1)^2 =
$$

$$
= \frac{37-26\theta+5\theta^2}{(8-5\theta+\theta^2)^2}
$$

$$
\pi_1^{SS} = \frac{(1-\theta)^2(11-8\theta+\theta^2)}{(8-5\theta+\theta^2)^2}
$$

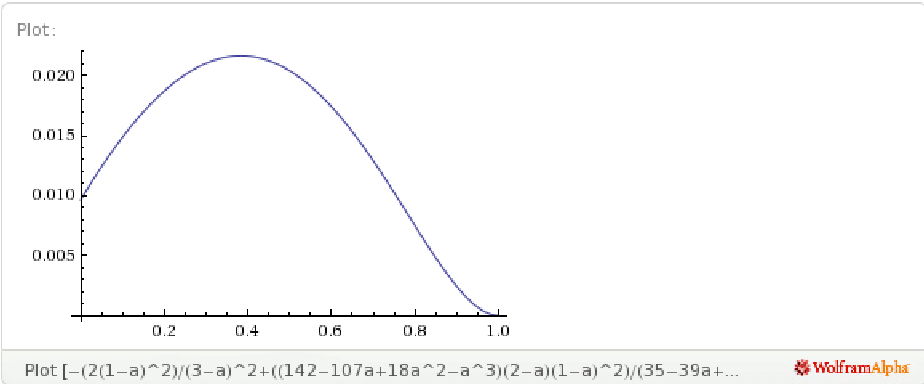
$$
\pi_2^{SS} = \frac{11+25\theta-28\theta^2+9\theta^3-\theta^4}{(8-5\theta+\theta^2)^2}
$$

The extended game.

Now we calculate the best response (BR) functions for both players.

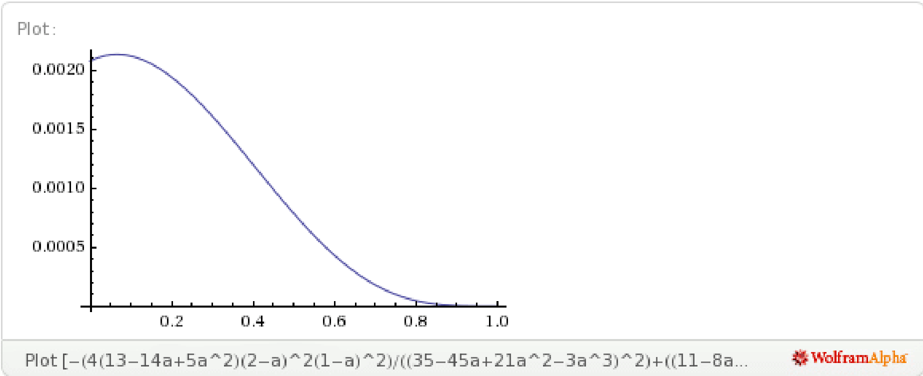
For private firm

If SC firm rents we should check the difference between $\pi_1^{SR}(\theta)$ and $\pi_1^{RR}(\theta)$. Using Wolfram we come to conclusion that for every $\theta \in [0,1)$: $\pi_1^{SR}(\theta) - \pi_1^{RR}(\theta) > 0$ (see Graph 1), therefore for every $\theta \in [0,1)$: $BR_1(R) = S$



Graph 1. Difference between selling and renting decisions for private firm if SC firm chooses renting.

If SC firm sells we should check the difference between $\pi_1^{SS}(\theta)$ and $\pi_1^{RS}(\theta)$. Using Wolfram we come to conclusion that for every $\theta \in [0,1)$: $\pi_1^{SS}(\theta) - \pi_1^{RS}(\theta) > 0$ (see Graph 2), therefore for every $\theta \in [0,1)$: $BR_1(S) = S$



Graph 2. Difference between selling and renting decisions for private firm if SC firm chooses selling.

Proposition 2. In the mixed duopoly durable goods market the best reaction of a private firm is to sell. This decision does not depend on the action of SC firm and parameter θ.

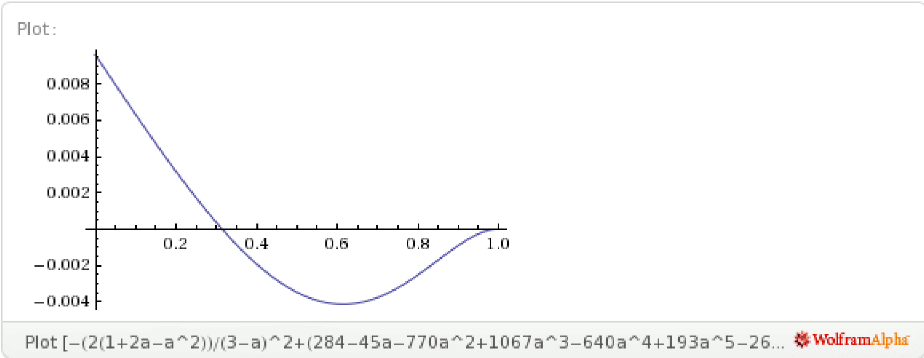
For SC firm

If private firm rents we should check the difference between $\pi_2^{RR}(\theta)$ and $\pi_2^{RS}(\theta)$.

Using Wolfram we come to conclusion that (see Graph 3)

if $0 \le \theta \le \theta^* = 0.3145$: $\pi_2^{RS}(\theta) - \pi_2^{RR}(\theta) > 0$ and $BR_2(R) = S$

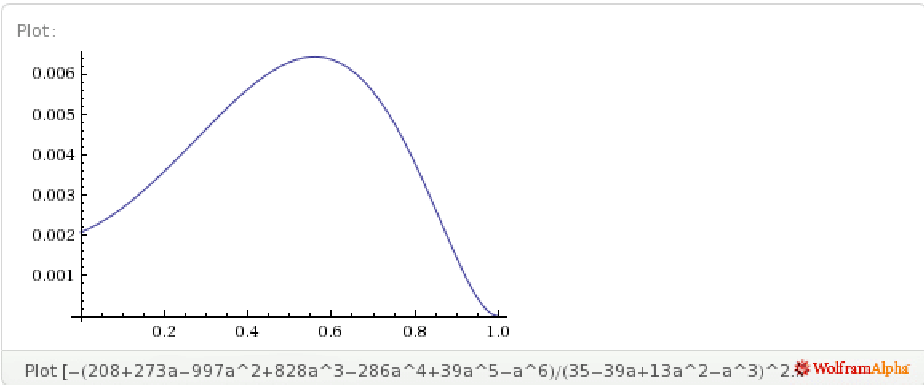
if $1 > \theta \ge \theta^* = 0.3145$: $\pi_2^{RS}(\theta) - \pi_2^{RR}(\theta) < 0$ and $BR_2(R) = R$



Graph 3. Difference between selling and renting for SC firm if private firm chooses renting.

If private firm sells we should check the difference between $\pi_2^{SS}(\theta)$ and $\pi_2^{SR}(\theta)$.

Using Wolfram we come to conclusion that for every $\theta \in [0,1)$: $\pi_2^{SS}(\theta) - \pi_2^{SR}(\theta) > 0$ (see Graph 4), therefore for every $\theta \in [0,1)$: $BR_2(S) = S$



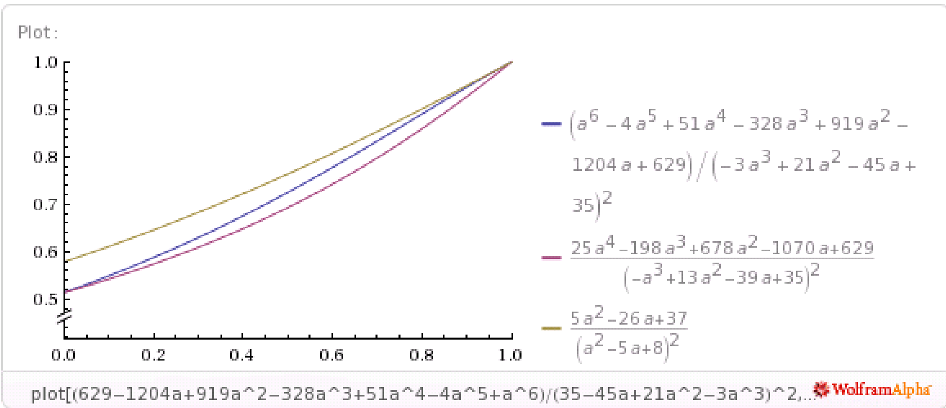
Graph 4. Difference between selling and renting decisions for SC firm if private firm chooses selling.

Proposition 3. In a mixed duopoly durable goods market the best reaction of the SC firm is to sell if private firm sells. But if private firm chooses renting, the decision of SC firm does depend on the parameter θ: if $\theta \le 0.3145$ it chooses selling, but if SC firm has strong benefits from social welfare ($\theta > 0.3145$) it chooses renting.

Joining together BR functions of private firm and SC firm we come to the following conclusion.

Proposition 4. In a mixed duopoly durable goods market (S,S) is the only Nash equilibrium for any parameter θ. At the same time for every θ (R,R) gives better outcomes for both players than (S,S). Moreover, if $\theta > 0.3145$ (R,R) is the best outcome for SC firm and therefore it has no incentive to deviate from cooperative outcome (R,R).

Now we can compare which decision is optimal for the society. Using Wolfram (see Graph 5) we can conclude that for every $\theta \in [0,1)$: $CS^{RR}(\theta) < CS^{SR}(\theta) < CS^{RS}(\theta) < CS^{SS}(\theta)$



Graph 5. Dependence of CS on parameter θ in different cases

Proposition 5. In a mixed duopoly durable goods market the only Nash equilibrium (S, S) is socially optimal. If firms make other decisions, consumer surplus decreases.

Chapter 5

COMPETITION BETWEEN TWO SOCIALLY CONCERNED FIRMS

Now we consider that instead of two firms that have different concerns about social welfare (0 and θ) we have two firms that care about society in the same way ($\frac{\theta}{2}$ and $\frac{\theta}{2}$). We'll try to investigate this situation, when firms are the same in their attitude to social welfare.

We start solving the game by the method of backward induction. In this game, in the pre-play period 3 scenarios are considered:

1. Both firms decide to rent
2. Firm 1 rents and firm 2 sells (As firms have the same preferences, case in which firm 1 sells and firm 2 rents gives the same results)
3. Both firms decide to sell.

We investigate each of these 3 cases (subgames) separately while solving this game.

Case 1. Renting/Renting

In the case of renting/renting consumers will be obligated to return goods after the first period. Therefore, in the second period firms will face with the same demand curve as in the first period. As a result we can investigate 1-period case and it will be sufficient to receive the answer.

Let x - amount of good that 1st firm produces,

y - amount of good that 2nd firm produces.

Then price for the good will be determined from the linear demand curve $p(Q) = a - Q$, where Q is the aggregate supply.

Therefore $p = a - x - y$.

Profit functions for the firms will be determined as the following:

$$\pi_1 = x(a - x - y) + \frac{\theta}{2} * CS$$

$$\pi_2 = y(a - x - y) + \frac{\theta}{2} * CS$$, where CS is consumer surplus.

As we already know for the linear demand curve $CS = \frac{1}{2}(x + y)^2$.

Therefore $\pi_1 = x(a - x - y) + \frac{\theta}{2} * \frac{1}{2}(x + y)^2$

$$\pi_2 = y(a - x - y) + \frac{\theta}{2} * \frac{1}{2}(x + y)^2.$$

Write down first-order conditions to determine Nash equilibrium of this subgame:

$$\begin{cases} \frac{\partial \pi_1}{\partial x} = a - y - 2x + \frac{\theta}{2}(x + y) = 0 \\ \frac{\partial \pi_2}{\partial y} = a - x - 2y + \frac{\theta}{2}(x + y) = 0 \end{cases}$$

Solving this system we receive:

$$\begin{cases} x = \frac{1}{3 - \theta} a \geq \frac{1}{3} a \\ y = \frac{1}{3 - \theta} a \geq \frac{1}{3} a \end{cases}$$

$$x + y = \frac{2}{3 - \theta} a \geq \frac{2}{3} a$$

$$p = a - x - y = \frac{1 - \theta}{3 - \theta} a \leq \frac{1}{3} a$$

Substituting obtained x and y into profit functions we obtain:

$$\pi_1^R = px + \frac{\theta}{2} * \frac{1}{2}(x+y)^2 = \frac{1}{(3-\theta)^2}a^2$$

$$\pi_2^R = py + \frac{\theta}{2} * \frac{1}{2}(x+y)^2 = \frac{1}{(3-\theta)^2}a^2$$

Taking into account that renting/renting case is equivalent to 2 sequential 1-period games we receive:

$$\pi_1^{RR} = 2\pi_1^R = \frac{2}{(3-\theta)^2}a^2$$

$$\pi_2^{RR} = 2\pi_2^R = \frac{2}{(3-\theta)^2}a^2$$

$$CS^{RR} = 2CS^R = (x+y)^2 = \frac{4}{(3-\theta)^2}$$

Case 2.Renting/Selling

Let x_1 - amount of good that 1st (private) firm rents in the first period,

y_1 - amount of good that 2nd firm (NPO) sells in the first period.

x_2 - amount of good that 1st (private) firm sells in the second period,

y_2 - amount of good that 2nd firm (NPO) produces in the second period.

Let's use backward induction to analyze this case.

In the second period both firms face the following demand curve $p(Q) = a - y_1 - Q$ (as y_1 units were already sold in the first period).

Therefore, as was shown in renting/renting case firms choose the following quantities in the second period:

$$x_2 = \frac{1}{3-\theta}(a - y_1)$$

$$y_2 = \frac{1}{3-\theta}(a - y_1)$$

Price, which is set up by firms in the second period:

$$p_2 = \frac{1-\theta}{3-\theta}(a - y_1)$$

Then profits received by firms in the second period are given by the following formulas:

$$CS_{(2)}^{RS} = \frac{2}{(3-\theta)^2}(a - y_1)^2$$

$$\pi_1^{(2)} = \frac{2}{(3-\theta)^2}(a - y_1)^2$$

$$\pi_2^{(2)} = \frac{2}{(3-\theta)^2}(a - y_1)^2$$

Now move back to the first period. For this very period both renting and selling are present, there are 2 prices on the market: price for selling p_1^S and price for renting p_1^R.

The necessary condition for co-existence of both activities: $p_1^S = p_1^R + p_2$ (otherwise all consumers prefer one activity to another).

The second one is the condition for marginal consumer, which is indifferent between buying in the first period at a higher price, then using the good during second period and buying it in the second period at a lower price:

$$2[a - x_1 - y_1] - p_1^S = a - x_1 - y_1 - p_2$$

From these conditions we obtain that:

$$p_1^R = a - x_1 - y_1$$

$$p_1^S = \frac{4-2\theta}{3-\theta}(a - y_1) - x_1$$

Substituting received prices into profit functions we get:

$$\pi_1 = p_1^R x_1 + \frac{\theta}{2} * CS_1 + \pi_1^{(2)} = x_1(a - x_1 - y_1) + \frac{\theta}{2} * CS_1 + \left(\frac{1-\theta}{3-\theta}\right)^2 (a - y_1)^2$$

$$\pi_2 = p_1^S y_1 + \frac{\theta}{2} * CS_1 + \pi_2^{(2)} = \frac{4-2\theta}{3-\theta}(a - y_1) - x_1 + \frac{\theta}{2} * CS_1 + \left(\frac{1-\theta}{3-\theta}\right)^2 (a - y_1)^2$$

Consumer surplus when both renting and selling are present

$$CS_{(2)}^{RS} = \int_{a-y_1}^{a} (2v - p_1^S) dv + \int_{a-y_1-x_1}^{a-y_1} (v - p_1^R) dv = \int_{a-y_1-x_1}^{a} (v - p_1^R) dv + \int_{a-y_1}^{a} (v - p_2) dv =$$

$$= \frac{1}{2}(x_1 + y_1)^2 + \frac{2}{3-\theta}(a - y_1) y_1 + \frac{1}{2} y_1^2$$

Write down first-order conditions to determine Nash equilibrium of this subgame:

$$\begin{cases} \dfrac{\partial \pi_1}{\partial x_1} = a - y - 2x + \dfrac{\theta}{2}(x + y) = 0 \\ \dfrac{\partial \pi_2}{\partial y_1} = \dfrac{4-2\theta}{3-\theta}(a - 2y_1) - x_1 + \dfrac{\theta}{2}\left[(x_1 + y_1) + \dfrac{2}{3-\theta}(a - 2y_1) + y_1\right] - \\ - \dfrac{2}{(3-\theta)^2}(a - y_1) = 0 \end{cases}$$

Solving this system we receive:

$$\begin{cases} x_1 = \dfrac{24 - 10\theta + 2\theta^2}{70 - 49\theta + 12\theta^2 - \theta^3} a \\ y_1 = \dfrac{22 - 6\theta}{70 - 49\theta + 12\theta^2 - \theta^3} a \end{cases}$$

Plugging these values we receive the following results:

$$x_2 = \frac{4(2-\theta)(1-\theta)^2}{35-45\theta+21\theta^2-3\theta^3}a \qquad y_2 = \frac{4(2-\theta)(1-\theta)(1+\theta)}{35-45\theta+21\theta^2-3\theta^3}a$$

$$p_2 = \frac{16-25\theta+10\theta^2-\theta^3}{70-49\theta+12\theta^2-\theta^3}a \qquad p_1^R = \frac{24-33\theta+10\theta^2-\theta^3}{70-49\theta+12\theta^2-\theta^3}a$$

$$p_1^S = \frac{8-10\theta+2\theta^2}{14-7\theta+\theta^2}a$$

Substituting received prices into profit functions we get:

$$\pi_1^{RS} = \frac{832-318\theta+3\theta^2-13\theta^3+9\theta^4-\theta^5}{(70-49\theta+12\theta^2-\theta^3)^2}a^2$$

$$\pi_2^{RS} = \frac{1136-802\theta+173\theta^2+13\theta^3-9\theta^4+\theta^5}{(70-49\theta+12\theta^2-\theta^3)^2}a^2$$

$$CS^{RS} = CS_{(1)}^{RS} + CS_{(2)}^{RS} = \frac{1}{2}(x_1+y_1)^2 + \frac{2}{3-\theta}(a-y_1)y_1 + \frac{1}{2}y_1^2 + \frac{1}{2}(x_2+y_2)^2 =$$
$$= \frac{4(629-508\theta+154\theta^2-20\theta^3+\theta^4)}{(70-49\theta+12\theta^2-\theta^3)^2}$$

Case 3. Selling/Selling

Let x_1 - amount of good that 1st firm sells in the first period,

y_1 - amount of good that 2nd firm sells in the first period.

x_2 - amount of good that 1st firm sells in the second period,

y_2 - amount of good that 2nd firm sells in the second period.

Let's use backward induction to analyze this case.

In the second period both firms face the following demand curve $p(Q) = a - x_1 - y_1 - Q$ (as $x_1 + y_1$ units were already sold in the first period).

Therefore, as was shown in renting/renting case firms choose the following quantities in the second period:

$$x_2 = \frac{1}{3-\theta}(a - x_1 - y_1) \qquad y_2 = \frac{1}{3-\theta}(a - x_1 - y_1)$$

Price, which is set up by firms in the second period:

$$p_2 = \frac{1-\theta}{3-\theta}(a - x_1 - y_1)$$

Then profits received by firms in the second period are given by the following formulas:

$$CS_{(2)}^{SS} = \frac{2}{(3-\theta)^2}(a - x_1 - y_1)^2$$

$$\pi_1^{(2)} = \frac{1}{(3-\theta)^2}(a - x_1 - y_1)^2 \qquad \pi_2^{(2)} = \frac{1}{(3-\theta)^2}(a - x_1 - y_1)^2$$

Now move back to the first period. Marginal consumer should be indifferent between buying good at a higher price in the first period, then using it for both periods and buying good at a lower price in the second period:

$$2(a - x_1 - y_1) - p_1 = (a - x_1 - y_1) - p_2$$

Therefore

$$p_1 = \frac{4-2\theta}{3-\theta}(a - x_1 - y_1)$$

Substituting prices into profit functions, we receive:

$$\pi_1 = p_1 x_1 + \frac{\theta}{2} * CS_{(1)}^{SS} + \pi_1^{(2)} = \frac{4-2\theta}{3-\theta}(a - x_1 - y_1)x_1 + \frac{\theta}{2} * (x_1 + y_1)[\frac{2}{3-\theta}a +$$
$$+ \frac{1-\theta}{3-\theta}(x_1 + y_1)] + \frac{1}{(3-\theta)^2}(a - x_1 - y_1)^2$$

$$\pi_2 = p_1 y_1 + \frac{\theta}{2} * CS_{(1)}^{SS} + \pi_2^{(2)} = \frac{4-2\theta}{3-\theta}(a - x_1 - y_1)y_1 + \frac{\theta}{2} * (x_1 + y_1)[\frac{2}{3-\theta}a +$$
$$+ \frac{1-\theta}{3-\theta}(x_1 + y_1)] + \frac{1}{(3-\theta)^2}(a - x_1 - y_1)^2$$

Write down first-order conditions to determine Nash equilibrium of this subgame:

$$\begin{cases} \frac{\partial \pi_1}{\partial x_1} = \frac{4-2\theta}{3-\theta}(a-y_1-2x_1) + \frac{\theta}{2}\left[\frac{2}{3-\theta}a + 2\frac{1-\theta}{3-\theta}(x_1+y_1)\right] - \\ -\frac{2}{(3-\theta)^2}(a-x_1-y_1) = 0 \\ \frac{\partial \pi_2}{\partial y_1} = \frac{4-2\theta}{3-\theta}(a-2y_1-x_1) + \frac{\theta}{2}\left[\frac{2}{3-\theta}a + 2\frac{1-\theta}{3-\theta}(x_1+y_1)\right] - \\ -\frac{2}{(3-\theta)^2}(a-x_1-y_1) = 0 \end{cases}$$

Solving this system we receive:

$$\begin{cases} x_1 = \frac{5-\theta}{16-10\theta+2\theta^2}a \\ y_1 = \frac{5-\theta}{16-10\theta+2\theta^2}a \end{cases}$$

Plugging these values we receive the following results:

$$x_2 = \frac{1-\theta}{8-5\theta+\theta^2} \qquad y_2 = \frac{1-\theta}{8-5\theta+\theta^2}$$

$$p_2 = \frac{(1-\theta)^2}{8-5\theta+\theta^2} \qquad p_1 = \frac{2(1-\theta)(2-\theta)}{8-5\theta+\theta^2}$$

Substituting received prices into profit functions we get:

$$CS^{SS} = CS^{SS}_{(1)} + CS^{SS}_{(2)} = (x_1+y_1)[\frac{2}{3-\theta}a + \frac{1-\theta}{3-\theta}(x_1+y_1)] + \frac{2}{(3-\theta)^2}(a-x_1-y_1)^2 =$$

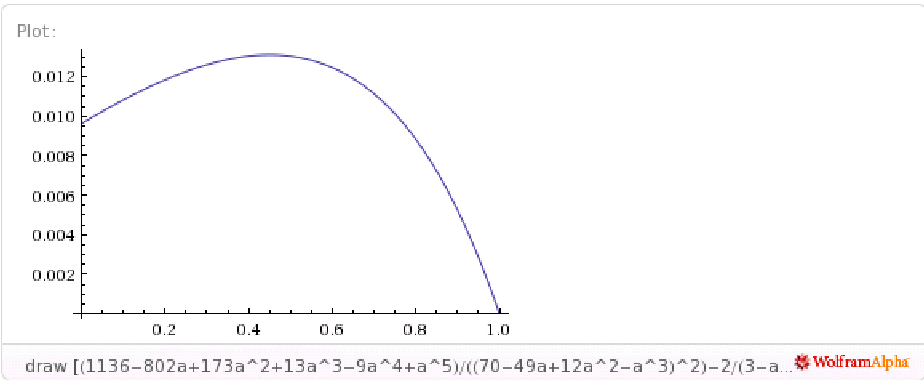
$$= \frac{37-26\theta+5\theta^2}{(8-5\theta+\theta^2)^2}$$

$$\pi_1^{SS} = \pi_2^{SS} = \frac{22-3\theta-4\theta^2+\theta^3}{2(8-5\theta+\theta^2)^2}$$

The extended game.

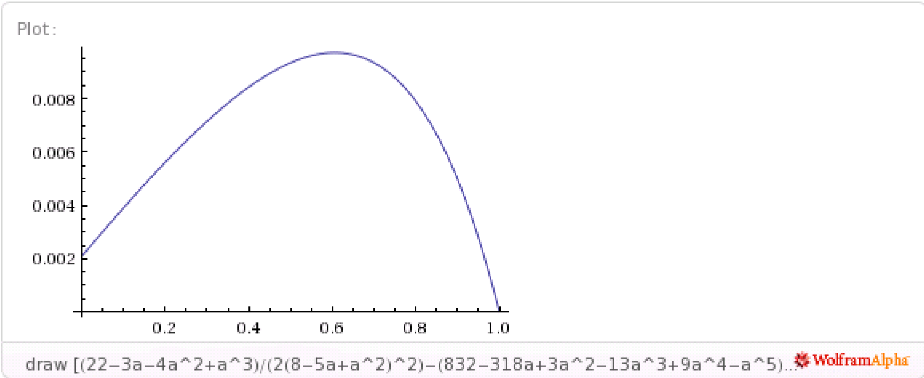
Now it is sufficient to calculate the best response (BR) function for firm 1 (as both firms have the same preferences).

If firm 2 rents we should check the difference between $\pi_1^{SR}(\theta)$ and $\pi_1^{RR}(\theta)$. Using Wolfram we come to conclusion that for every $\theta \in [0,1)$: $\pi_1^{SR}(\theta) - \pi_1^{RR}(\theta) > 0$ (see Graph 6), therefore for every $\theta \in [0,1)$: $BR_1(R) = S$



Graph 6. Difference between selling and renting outcomes for firm 1, if firm 2 chooses renting.

If SC firm sells we should check the difference between $\pi_1^{SS}(\theta)$ and $\pi_1^{RS}(\theta)$. Using Wolfram we come to conclusion that for every $\theta \in [0,1)$: $\pi_1^{SS}(\theta) - \pi_1^{RS}(\theta) > 0$ (see Graph 7), therefore for every $\theta \in [0,1)$: $BR_1(S) = S$



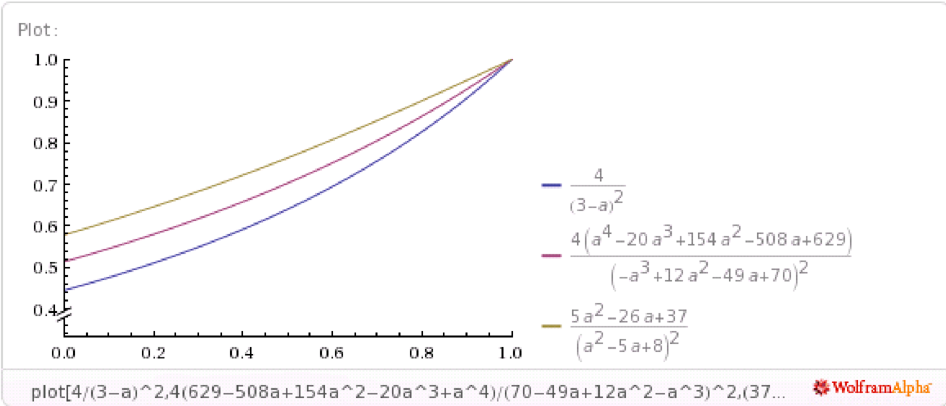
Graph 7. Difference between selling and renting outcomes for firm 1, if firm 2 chooses selling.

Proposition 6. In the case of durable goods market, where both firms are socially concerned, the best reaction of any firm is to sell. This decision does not depend on the action of another firm and parameter θ.

Joining together BR functions for both firms we come to the following conclusion.

Proposition 7. In a durable goods duopoly, where both firms are socially concerned, (S, S) is the only Nash equilibrium for any parameter θ.

Now we can compare which decision is optimal for the society. Using Wolfram (see Graph 8) we can conclude that for every $\theta \in [0,1)$: $CS^{RR}(\theta) < CS^{RS}(\theta) < CS^{SS}(\theta)$



Graph 8. Dependence of CS on parameter θ in different cases.

Proposition 8. If 2 firms participating on the market are equally socially concerned, the only Nash equilibrium (S, S) is socially optimal. If firms make other decisions, consumer surplus decreases.

Chapter 6

CONCLUSIONS

In this paper we investigate the influence of socially concerned firms on durable goods market. We came to conclusion that the influence of presence of SC firm on selling/renting decisions on the market does not differ from the classical case, when only private firms were considered. We introduced a crucial parameter θ, which can be interpreted as share of social welfare that goes (directly or indirectly) to a firm. We admit that a case $\theta=0$ corresponds to the case of purely private firm. In Chapter 5 we considered the case when private firm (with nonzero θ) competes with socially concerned firm. Then for every value of θ, kind of classical Prisoners' Dilemma exists: (selling, selling) is the only Nash equilibrium in this game, whereas (renting, renting) strictly dominates this equilibrium. The only difference with pure duopoly case is that for $\theta > 0.31$ one of the "prisoners", socially concerned firm has no incentive to deviate from the cooperative outcome.
In Chapter 6 we considered a situation when the share of social welfare θ is divided equally between 2 firms, which are participating on the market. The results show presence of the same Prisoners' Dilemma for every value of θ. The only Nash equilibrium (selling, selling) is also a socially optimal outcome, although in the case of (renting, renting) both firms receive higher profits.

Now we can compare monopoly results with different kinds of duopolies for durable goods market (pure and mixed). We can conclude that regardless the character of duopoly there is a change in selling/renting decisions. Whereas a monopolist is better off under renting strategy, if a competitor appears, it does not matter whether it is private or socially concerned, marked change in behaviour occurs: former monopolist switches to selling. Even for socially concerned competitor the best reaction is to follow ex-monopolist and choose selling. As a result both firms sell and therefore they produce a larger amount of production together as it is better for them to produce more at a price, which is higher than in the second period. As a result firms produce non-optimally high output and receive lower price for it under Cournot competition comparing with cooperative outcome. This leads to lower firms' profits, but higher consumers' welfare.

To sum up, we can admit the fact that selling/renting decisions almost do not depend on the kind of duopoly (only renting/renting may become more preferable). The reason behind it that even socially concerned firm cares more about own profit than about social welfare (it is reflected by condition $\theta < 1$). In particular, we can conclude more active presence of NPO on durable goods market will not cause dramatic changes on current market activities.

Therefore the following policy recommendations may be proposed.

If government wants to change renting behavior of the monopolist, it should encourage competitors to move onto the market (of course if it is possible) and should care less about the attitude to the social welfare, as the character of accepted renting/selling decisions will be similar.

WORKS CITED

Benz, M. 2005. “Not for Profit, but for Satisfaction?- Evidence on Worker Well-Being in Non-Profit Firms,” *Kyklos*, Vol. 58, No. 2, pp.155-176.

Bucovetsky, S. and J. Chilton. 1986. Concurrent renting and selling in a durable-goods monopoly under threat of entry. *Rand Journal of Economics* 17(2), 261–275.

Bulow, Jeremy. 1982. Durable Goods Monopolists. *Journal of Political Economy* 90: 314-332.

Bulow, Jeremy. 1986. An Economic Theory of Planned Obsolescence. *Quartely Journal of Economics* 101: 729-749.

Case, S. “Purpose and Profit go Together”. 2005. *Wall Street Journal* (Eastern Edition) New York, N.Y.: pg B.2.

Coase, Ronald. 1972. Durability and Monopoly. *Journal of Law and Economics* 15: 143-149.

Goering, Gregory. 1993. Durability Choice Under Demand Uncertainty. *Economica* 60: 397-411.

Goering, Gregory. 2005. Durable Goods Monopoly and Quality Choice. *Research in Economics* 59: 59-66.

Goering, Gregory. 2008. Socially Concerned Firms and the Provision of Durable Goods. *Economic Modelling* 25: 575-583.

Inderst, Roman. 2008. Durable Goods with Quality Differentiation. *Economics Letters* 100: 173-177.

Kuhn, U. and J. Padilla. 1996. Product line decisions and the Coase conjecture. *Rand Journal of Economics* 27: 391–414.

Kumar, Praveen. 2002. Price and Quality Discrimination in Durable Doods Monopoly with Resale Trading. *International Journal of Industrial Organization* 20: 1313-1339.

Lu, Y., and S. Poddar. 2005. Mixed Oligopoly and the Choice of Capacity. *Research in Economics* 59. 365-374.

Lu, Y., and S. Poddar. 2006. The Choice of Capacity in Mixed Duopoly under Demand Uncertainty. *Manchester School* 74, 266-272.

Marwell, N., and P. McInerney. 2005. The Nonprofit/For-Profit Continuum: Theorizing the Dynamics of Mixed-Form Markets. *Nonprofit and Voluntary Sector Quarterly* 34, No. 1, pp. 7.

Nishimori, A., and H. Ogawa. 2004. Do Firms always Choose Excess Capacity? *Economics Bulletin* 12, 1-7.

Ogawa, Hikaru. 2006. Capacity Choice in the Mixed duopoly with Product Differentiation." *Economics Bulletin*, Vol. 12, No. 8 pp. 1-6

Poddar, Sougata. 2004. Strategic Choice in Durable Goods Market when Firms Move Simultaneously. *Research in Economics* 58: 175-186.

Saggi, K. and N. Vettas. 2000. Leasing Versus Selling and Firm Efficiency in Oligopoly. *Economics Letters* 66: 361-368.