A comparison of markets with and without switching costs

The influence of switching costs on market prices

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ABSTRACT

Research shows that switching costs have effect on prices, market share and competition within the markets. In this paper, an analysis is made regarding switching costs in a two-time period. Consumers valuation influencing the profit is controlled for. This results in two different profit functions, one with and one without switching costs. Our results show indeed, what Klemperer states: markets will become less competitive within markets when switching costs occur.

KEYWORDS

Switching costs, duopoly, price competition, two-period model

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1. INTRODUCTION

The phenomenon of switching costs is well-known in economic literature. Switching costs are defined as the costs to switch, while consumers already invested in another almost homogenous product in the former period. There are multiple reasons to switch, for example price shifts in the price of the competitor.

A well-known example of switching costs are computer keyboards. For decennia, consumers work on Qwerty-keyboards because through the years, we got used to it. There is an alternative, Dvorak, which is more efficient. It would be a better option to implement this in the firm, but the switching costs are too high to switch from Qwerty-keyboards to Dvorak-keyboards (Bigler, 2003). First of all, there are implementation costs to implement a Dvorak-keyboard in an organization. Secondly, there are costs to teach the employees to work with Dvorak-keyboards.

Another example is accounting software. Suppose a firm uses a typical accounting program, say Excel, and organizes itself with that software. There could be an alternative, which is better, faster and cheaper. The management is not willing to change the standard software, since it costs too much to teach all the employees to work with the new product. This means that the firm is restricted; its switching costs are too high to switch to the newer software.

For managers, switching costs are also an interesting case. As an example, switching costs play a role in their price setting strategy for a longer period. Managers know that consumers are taking switching costs into account, since rational consumers incorporate this in their price setting for multiple or infinite periods. As a consequence, managers are more concerned about market shares than about first period short run profits. For instance: assume there are two periods with two almost homogenous products. When one firm undercuts the other firm, perhaps its short run profit is lower, but that firm gains a greater market share. In the second period, consumers will not switch to another firm when they are facing switching costs. So in the second period, firms have locked-in consumers and therefore have a higher profit over their whole lifetime.

In the past decades, switching costs have been a popular subject for economic research. Multiple economists used a two-time-period to analyze markets with switching costs, for example Von Weizsäcker (1984), Klemperer (1987a), Banerjee & Summers (1987). Besides two-time-period research, Klemperer and Beggs (1992) analyzed the evolution of duopolistic prices and market shares, under the condition of an infinite-period market with consumer switching costs. Researchers have come to different conclusions on how much competition there is in markets when switching costs occur. Nevertheless, the main conclusion is that there is less competition in markets when there are switching costs. More in-depth literature will be discussed in the theoretical framework (**Section 2**).

The upper section has shown that switching costs are an interesting economic subject and that a lot of research has been done. In this paper a two-period model is set up. The differences between markets with and without switching costs are calculated, like other researchers did before on this topic. A crucial difference between this paper and other papers is the fact that in this paper, the valuation of the consumers is taken as a starting point to calculate the optimal prices. Furthermore, this research shows the effects of switching costs on markets. The central question in this paper is: Is the outcome of this paper in line with Klemperers conclusion, that states that firms in markets with switching costs are more profitable than firms in markets without. This is because markets with switching costs are less competitive.

The results of our research are indeed in line with Klemperer. The reason for this is the fact that firms take into consideration the decisions of the consumers, because consumers incorporate the costs of switching in their choices. What follows is that with the right price-setting, only firms benefit due to the fact that there are switching costs in the market.

The structure of this thesis is as follows. Section 2 discusses the relevant literature regarding oligopolies, duopolies and switching costs. Section 3 describes the model and its assumptions. The analysis with the different models is described in Section 4. Lastly, Section 5 concludes with a summary of the main results and recommendation for further research.

2. THEORETICAL FRAMEWORK

As stated in the introduction, plenty research has been done about switching costs. In this part, a section describes the markets where switching costs occur namely oligopolies and duopolies. Thereafter, some different papers about switching costs will be reviewed.

2.1. Oligopoly and duopoly markets

Roughly, there are four different types of markets to differentiate: markets with perfect competition, markets with monopolistic competition, oligopoly and monopoly. In the table below, the differences have been set out:

	Perfect Competition	Monopolistic Competition	Oligopoly	Monopoly
Number of Firms	Very large	Many	Few	One
Type of Product	Standardized	Differentiated	Standardized and differentiated	Unique
Control over price	None	Slight	Considerable	Considerable if not regulated
Entry barriers	No barriers	No barriers	Large barriers	Large barriers
Examples	Wheat soybeans	Restaurants	Automobiles	Patented drugs

(Osman)

Switching costs appear in markets with few firms. When there is a monopolistic market, consumers have no other option than to choose for the monopolistic supplier. As a result, consumers cannot switch and switching costs do not occur. Defining and measuring switching costs in perfect competition markets is difficult for companies (and for researches too), due to the fact that there are many alternatives (products as well as suppliers) where consumers can choose from.

Forthcoming, it is most likely that firms who operate in oligopoly markets take the switching costs of the consumers into account the most. In oligopolies, firms have market power because relatively a few firms provide the good. The price competition is less severe than in markets with perfect competition (Herriges, 2010). An example of an oligopoly is the market for cell phones in the United States. The market is currently dominated by Verizon Wireless, AT&T and Spirit. In a market with so few firms, firms know that reducing or increasing the output or price, has an immediate effect on the prices and quantities of competitors (Serrano & Feldman, 2010).

The simplest version of oligopolies are duopolies. Duopolies are oligopolies with two firms in the market. Since the nineteenth century, research has been done on this subject, and the analysis of strategic behavior is the heart of the twentieth century discipline called game theory. There are two different types of duopolies: (i) Duopolistic firms compete with each other through their choice of quantity they produce. This approach was designed by Cournot. (ii) Duopolists who compete with the prices they are charging. This was developed by Bertrand in 1883. In both models, firms and consumers simultaneously choose their price or quantity. A special alternative is the alternative when firms sequentially decide their quantity or price. This is called Stackelberg competition: the first firm sets its price and a follower anticipates on the behavior of its competitor.

2.2. Switching costs in economic literature

In this section, the literature about switching costs is summarized. In his introduction, Klemperer (1987) describes the reasons why there are switching costs. Klemperer states that there are three different types of switching costs: (i) Learning costs, for example switching to another software after learning how to use the existing software. (ii) Transaction costs, these costs occur when changing from one service to another. Examples are telephone services or library services. (iii) Repeat-purchase coupons, for example 'frequent-flyer' passes. For instance, people who buy a flight ticket to America in period 1, get a discount of 10% for the next purchase. Consumers incorporate this in their decision for their next flight and which company to fly with. Also Banerjee and Summers (1987) and Klemperer (1987a) dive deeper into the subject of frequent-flyer programs. Klemperer explains in his paper (1987a) the following example: two airlines providing a flying route in each of the two periods. When the airlines come up with a frequent-flyer discount in the first period, they lock the consumers in for the next period. They 'lock-in' the consumers, because the consumers take into account the fact that they can have some discount. The first period will become more competitive than the second period, since there is regular duopoly competition. Consequently, the second period will become less competitive: consumers are forced to order their tickets at the same airline as they did in the first period. In the first period, the prices are Cournot prices. In the second period, consumers are 'locked-in' and are forced to buy the product again from the same firm. Prices increase with the amount of the discount, and the game becomes a monopoly setting. So it works out that the actual profiteers of the 'frequent-flyer' are only the firms. In the second period, the prices become monopoly prices. Another remarkable point is that it does not matter what the height of the discount is, because consumers are locked-in anyway.

In another paper about switching costs, Farrel and Shapiros (1988) show that the seller without a consumer base is willing to price more aggressively than the incumbent. As a result, the seller with a consumer base only sells to its own consumers and the new firm will attract all the unattached buyers. Furthermore, according to Farrell and Shapiro, in markets with switching costs it is possible for the incumbent to exclude entrants. Besides that, the researchers state that switching costs can cause inefficiency and they have identified the circumstances when dominance occurs. In their model, the incumbent sets the price above marginal and average costs, without inducing entry. Beggs and Klemperer (1992) develop and analyze an infinite-horizon model of competition in a market with switching costs in which every period new consumers arrive and a fraction of the old consumers can leave the market. This initial view came from Von Weizsäckers paper in 1984, where Von Weizsäcker assumes constant-price strategies. According to Beggs and Klemperer, Farrell and Shapiros paper had some failures: (i) Farrell and Shapiro assume that consumers always buy from the firm which offers the lowest price and they do not take the future into account. If consumers are rational, they consider the expected future prices when they are buying a product in the current period. (ii) Firms set prices sequentially, so there is a first mover advantage. Simultaneous price setting would be more realistic. (iii) There are two types of firms: one firm sells only to old consumers, the other one sells only to new consumers, where each firm always has a fifty percent market share. Beggs and Klemperer show that prices and profits are higher in a market with switching costs. They also show that prices rise as firms discount the future more, and fall when consumers discount the future more. As a consequence, the turnover of consumers increases and when the rate of growth of the market increases. Thirdly, this paper shows that when there are high profits in markets with switching costs, it can be that the market is more attractive than when there are no switching costs at all. Lastly, the researchers show that it becomes more attractive for entrants to enter the market with switching costs than markets without switching costs.

3. MODEL

This section explains the model we use. The model contains two firms A en B and consumers who valuate products differently (V_A , V_B) over time. In each period, consumers have three options: (i) buy product A, (ii) buy product B or (iii) stay out of the market. Consumers can have a different valuation of the goods in the two periods, so firms cannot learn from the consumers in the period before. Furthermore, consumers are rational and choose to buy product A, product B or to stay out, so:

- Product A: $V_A - V_B - P_A + P_B > 0 \wedge V_A > P_A$.
- Product B: $V_B - V_A - P_B + P_A > 0 \wedge V_B > P_B$.
- Those who stay out: $0 > V_A - P_A \wedge 0 > V_B - P_B$.

Since consumers are rational, consumers always choose the option which gives them the highest utility. Prices, switching costs and valuations are uniformly distributed between zero and one. As mentioned before, the market is a duopoly market with no firm entrants before or during the two periods. Furthermore, firms set their price between zero and one before every period. Firms are also rational and want the highest profits over their lifetime. For simplicity, marginal costs are assumed as zero, so the profit function is easily to derive for markets without switching costs:

- $\pi = Q * P_A = X * (1 - P_A) * P_A$.

X is the horizontal part of the demand (see figure in **Section 4.**). Firms know the outcomes of the first round before the second round. In this model, the Cournot model is taken as main model so with quantity competition and a simultaneous game, this means that there is no first-mover advantage: firms set their prices at the same time. The total market share is 1, so $1 - \sigma_A - \sigma_B = \sigma_N$, where σ_A are the buyers of product A, σ_B are the buyers of product B and σ_N are those who choose to stay out of the market in the former period. In the second period, switching costs occur. Thus this has to be in incorporated in the model for markets with switching costs.

There are two types of switching costs:

- s is the costs of switching from product A to product B.
- c is the costs of switching from product B to product A.

The demand of the products in the second period is divided into three parts. First of all, there are stayers, these are the buyers of product A in the period before. They have the possibility to buy product A again, switch to product B or can decide to quit the market. When consumers have bought product A in the first period, logically they do not have to pay the switching costs, but when they switch to product B, they have to. These consumers will incorporate switching costs in their decision-making process. The market share can be denoted as:

- $\sigma_A^{t-1}\,\mathrm{Pr}(V_A - P_A > 0 \wedge V_A \geq V_B - P_B + P_A - s)$.

The second group of consumers are those who have bought product B in the previous period, but have decided to quit or to switch to product A. If the consumers decide to buy product B, they do not have to incorporate the switching costs. However, if they consider to buy product A, they have to include the switching costs. So, the market share is:

- $\sigma_B^{t-1}\,\mathrm{Pr}(V_A - P_A > 0 \;\wedge V_A \geq V_B - P_B + P_A + c)$.

The people in the third group are those who did not buy anything in the period before, but they can decide to enter the market. They do not have to pay any switching costs, simply because they have not invested anything in the former period. Since it is assumed that all consumers are rational, they will stay out of the market when their pay-off is highest to stay out. But when, for example the prices have dropped in the current period compared to the previous period, consumers can choose to enter the market.

- $\sigma_N^{t-1}\,\mathrm{Pr}(> 0 \wedge V_A - P_A > V_B - P_B)$.

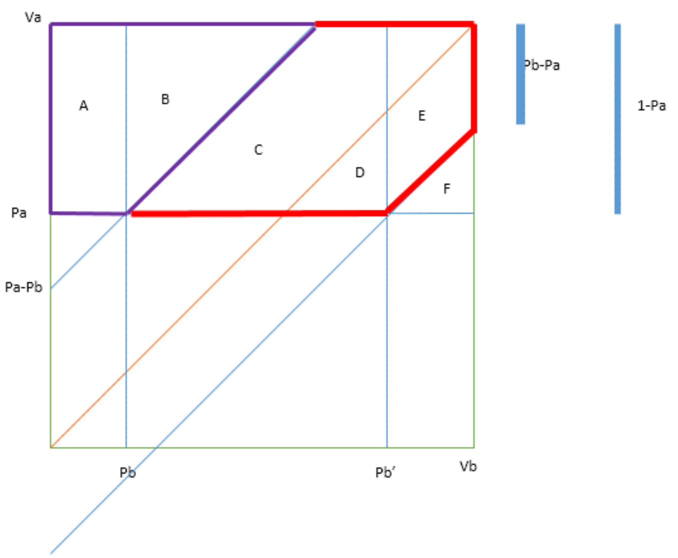
After the demand is defined, it is easy to derive the profit namely quantity times the price (also here, costs are assumed as zero). The comparison with and without switching costs is easy to make by subtracting the two different cases from each other.

4. ANALYSIS AND RESULTS

In this section, there is an analysis and result section. Firstly, there is a section about markets without switching costs, followed by a section about markets with switching costs. This section ends with a comparison between the two different markets.

4.1. Model without switching costs

In contrast to the next section, switching costs are not taken into account. As we have seen in **Section 3**, consumers who valuate the product A (V_A) minus the price of A (P_A) greater than the valuation of product B minus the price of product B will buy product A (all prices and valuations have to be above zero).



- $V_A - P_A > V_B - P_B \wedge V_A - P_A > 0.$

X is defined as the horizontal part of the demand, as can be found in the figure below. X times (1-P_A) is the total demand. The outcome times the price is the total profit.

- $\Pr_A(V_A > V_B + P_A - P_B \wedge V_A - P_A) = X.$
- $X_A(P_A, P_B) =$

$$\begin{cases} X = P_B + \frac{1-P_A}{2} \text{ if } P_A \geq P_B \\ X = P_B + \frac{(1-P_B)}{(1-P_A)} * \left((P_B - P_A) + \frac{1-P_A}{2}\right) = P_B + \frac{(1-P_B)^2}{2(1-P_A)} + \frac{(1-P_B)(P_B-P_A)}{1-P_A} \text{ if } P_A < P_B \end{cases}$$

In the graph above, it easy to see the different possibilities of P_A and P_B to calculate the demand:

- When $P_A > P_B$, it incorporates pane A and pane B (the upper 45 degrees line).
- When $P_A = P_B$, it incorporates pane A, B and C (the orange 45 degrees line).
- When $P_A < P_B$, it sums up all the panes except pane F (the lowest 45 degrees line).

When X is found, the total demand can be calculated. The demand times the price, gives the following profit function:

- $\pi_A(P_A, P_B) = \begin{cases} P_A(1-P_A)(P_B + \frac{1-P_A}{2}) \text{ if } P_A \geq P_B. \\ P_A(1-P_A)(P_B + \frac{(1-P_B)}{2}) + (1-P_B)(P_B - P_A)) \text{ if } P_A < P_B. \end{cases}$

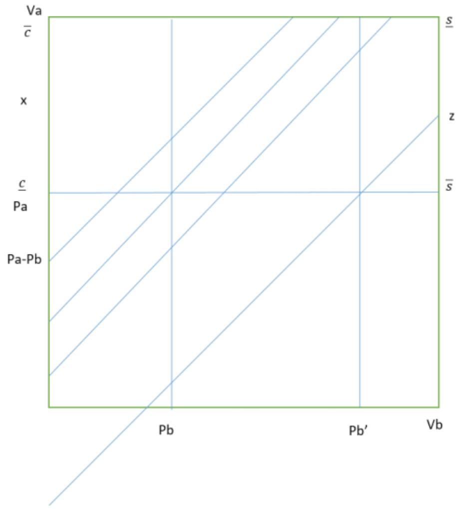
When the profits are derived with respect to the price, the optimal price can be calculated.

- $\frac{d\pi_A}{dP_A} = \begin{cases} -3P_A - 2P_AP_B + \frac{3}{2}{P_A}^2 = -P_B - \frac{1}{2} \text{if } P_A \geq P_B. \\ 3P_A - 2P_AP_B + \frac{3}{2}{P_A}^2 = -2P_B + \frac{1}{2} \text{ if } P_A < P_B. \end{cases}$

4.2. Model with switching costs

As mentioned in the Model section (**Section 3**), there are three groups of buyers, divided into nine different groups. In this section switching costs are taking into account. Without loss on generality, when $P_A \geq P_B$:

- $\sigma_A^{t-1} = (\underbrace{\int_{\bar{s}}^{1}(1-P_A)dz}_{I} + \underbrace{\int_{\underline{s}}^{\bar{s}}(1-P_A) - \frac{1}{2}(\bar{s}-z)^2dz}_{II} +$
  $\underbrace{\int_0^{\underline{s}}(1-P_A) * (1-P_A+P_B+z) - \frac{1}{2}(1-P_A)^2dz}_{III}$
- $\sigma_B^{t-1} = (\underbrace{\int_{\bar{c}}^{1} 0dx}_{IV} + \underbrace{\int_{\underline{c}}^{\bar{c}} \frac{1}{2}(\bar{c}-x)^2dx}_{V} + \underbrace{\int_0^{\underline{c}}(\underline{c}-x)(1-P_A) + \frac{1}{2}(1-P_A)^2dx}_{VI}$
- $\sigma_N^{t-1} = (\underbrace{P_B(1-P_A)}_{VII} + \underbrace{\frac{1}{2}(1-P_A)^2}_{VIII})$



When the quantity is defined in the section above, the profit, if $P_A \geq P_B$ is:

- $P_A * ((1-\overline{s}+P_A\overline{s}-P_A)+(1-P_A)(\overline{s}-\underline{s})+\frac{1}{6}(\overline{s}-\underline{s})^3\underline{s}-2\underline{s}P_A+2P_B+\frac{1}{2}\underline{s}^2+\underline{s}P_A{}^2-P_AP_B\underline{s}-\frac{1}{2}\underline{s}^2P_A-\frac{1}{2}\underline{s}(1-P_A)^2+\frac{1}{6}(\overline{c}-\underline{c})^3\underline{c}^2-\underline{c}^2P_A-\frac{1}{2}\underline{c}^2+\frac{1}{2}P_A\underline{c}^2+\frac{1}{2}\underline{c}(1-P_A)^2+(P_B-P_A)+\frac{1}{2}(1-P_A)^2)$

As can be found in the picture above, the switching costs can be rewritten in terms of P_A and P_B, so:

- $\overline{c} = 1-P_A+P_B$.
- $\underline{c} = P_B$.
- $\underline{s} = P_A-P_B$.
- $\overline{s} = P_A-P_B+1-P_A = 1-P_B$.

So, the nine different parts can be rewritten in terms of P_A and P_B:

- I: $P_B-P_AP_B$.
- II: $\frac{7}{6}-\frac{5}{2}P_A+\frac{3}{2}P_A{}^2-\frac{1}{6}P_A{}^3$.
- III: $\frac{1}{2}P_A+\frac{1}{2}P_A{}^2+\frac{1}{2}P_B+\frac{3}{2}P_AP_B-\frac{3}{2}P_A{}^2P_B+\frac{1}{2}P_AP_B{}^2$.
- IV: 0.
- V: $\frac{1}{6}-\frac{1}{2}P_A+\frac{1}{2}P_A{}^2-\frac{1}{6}P_A{}^3$.
- VI: $\frac{1}{2}P_B+\frac{1}{2}P_B{}^2-P_AP_B+\frac{1}{2}P_A{}^2P_B-\frac{1}{2}P_AP_B{}^2$.
- VII & $VIII$: $1-2P_A+\frac{1}{2}P_A{}^2+P_B$.

The total demand in terms of P_A and P_B is:

- $Q = \frac{11}{6} - \frac{9}{2}P_A + 3{P_A}^2 - \frac{1}{3}{P_A}^3 + 3P_B + \frac{1}{2}{P_B}^2 + \frac{1}{2}P_AP_B - {P_A}^2P_B$.

When the total demand is calculated, the profit function is the demand times price

- $\pi_{A,s.c.}(P_A, P_B) = \frac{11}{6}P_A - \frac{9}{2}{P_A}^2 + 3{P_A}^3 - \frac{1}{3}{P_A}^4 + 3P_AP_B + \frac{1}{2}P_A{P_B}^2 + \frac{1}{2}{P_A}^2P_B - {P_A}^3P_B$.

To calculate the optimal price, the profit function has to be divided by the price, so:

- $\frac{d\pi}{dP_A} = \frac{11}{6} - 9P_A + 9{P_A}^2 - \frac{4}{3}{P_A}^3 + 3P_B + \frac{1}{2}{P_B}^2 + P_AP_B - 3{P_A}^2P_B = 0$

4.3. The comparison with and without switching costs

In this part, a comparison between the outcomes in the previous sections is being made. Also the effects of switching costs on markets will be shown.

If there are no switching costs and if $P_A \geq P_B$, the total profit is (from **Section 4.1**):

- $\pi_{A\,,no,s.c.}(P_A, P_B) = \frac{1}{2}P_A - {P_A}^2 + \frac{1}{2}{P_A}^3 + P_AP_B - {P_A}^2P_B$.

When there are switching costs, the total profit is, if $P_A \geq P_B$ (from **Section 4.2**):

- $\pi_{A,s.c.}(P_A, P_B) = \frac{11}{6}P_A - \frac{9}{2}{P_A}^2 + 3{P_A}^3 - \frac{1}{3}{P_A}^4 + 3P_AP_B + \frac{1}{2}P_A{P_B}^2 + \frac{1}{2}{P_A}^2P_B - {P_A}^3P_B$.

As a consequence, the difference between markets with and without switching costs, if $P_A \geq P_B$ is:

- $\pi_{A,no\ s.c.}(P_A, P_B) - \pi_{A,s.c.}(P_A, P_B) = \frac{1}{2}P_A - {P_A}^2 + \frac{1}{2}{P_A}^3 + P_AP_B - {P_A}^2P_B - \left(\frac{11}{6}P_A - \frac{9}{2}{P_A}^2 + 3{P_A}^3 - \frac{1}{3}{P_A}^4 + 3P_AP_B + \frac{1}{2}P_A{P_B}^2 + \frac{1}{2}{P_A}^2P_B - {P_A}^3P_B\right)$.
- $\pi_{A,no\ s.c.}(P_A, P_B) - \pi_{A,s.c.}(P_A, P_B) = -\frac{4}{3}P_A + \frac{7}{2}{P_A}^2 - \frac{5}{2}{P_A}^3 + \frac{1}{3}{P_A}^4 - 2P_AP_B - \frac{1}{2}P_A{P_B}^2 - \frac{3}{2}{P_A}^2P_B + {P_A}^3P_B$.

Without loss on generality, when $P_A \geq P_B$, when some numbers are plugged in, it is easy to see that the profit for firm A is higher in markets with switching costs.

It is clear that markets with switching costs have greater profits than markets with no switching costs at all. Furthermore, this model shows that the difference between the profit with and without switching costs is high. Of course, this (fifth column) is not the lifetime profit, but the profit for the second period. The first period profit will be more a profit towards a perfect competition profit as Klemperer states in his paper.

P_A	P_B	ΔP	$\pi_{A,no\ s.c.}(P_A, P_B)$	$\pi_{A,s.c.}(P_A, P_B)$	$\Delta\pi$ (abs)
0.5	0.4	0.1	0.16	0.78	0.62
0.9	0.5	0.4	0.05	1.27	1.22
0.3	0.1	0.2	0.09	0.32	0.22

5. CONCLUSION

In this paper, we analyzed duopolies and the switching cost that may occur in those markets. We used a two-period model to calculate what the effects are on those markets. Summarizing, plenty of research has been done on switching costs in the last decades. Klemperer, Farrell and Shapiro have conducted influencing research on switching costs. Klemperers main conclusion is that markets will become less competitive if there are switching costs in set market. The central question in this paper is: Is Klemperers conclusion that profits for firms will be higher in markets with switching costs is in line with our model? During our research, we built a new model to calculate the effects of switching costs on markets.

If we plug in different prices for P_A and P_B in the different equations for firms with and without switching costs (see **Section 4.3**), it is clear that firms who operate in markets with switching costs can earn more money. Consequently, the profit is higher for firms that operate in markets with switching costs than without, due to switching costs. Firms incorporate these switching costs of consumers in their decision making. This result is in line with the conclusion of Klemperers, that states that firms in oligopoly markets with switching costs have benefits due to the fact that there are switching costs.

Limitations of this paper are that it was not possible to suppress P_A in terms of if P_B, due to the fact that there is a quartic polynomic in the equation. Furthermore, we limited ourselves to a simple model with no entrants, two firms and a set of consumers. The next step for research would be to analyze the price setting for three or more periods. Our expectations are that firms will choose to offer different prices, acting more aggressively in the first period to lock consumers in. Once consumers are locked in, firms will increase their prices. Research could also focus on the condition that entrants are able to enter the market in different time periods and that already involved firms are able to leave. Another research topic are cases where consumers value the product identical over their lifetime. As a consequence, firms could use this data to learn from their consumers in later stadia. This is more realistic but complicating. At last, price differentiation for different groups in multiple period models would be an interesting case as well.

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