Price discrimination or uniform pricing: Which colludes more?

Niklas Horstmann, Jan Krämer

Abstract

Conventional wisdom attributes different economic outcomes of uniform pricing and price discrimination to the heterogeneity in market conditions or market participants, such as differences in demand elasticity or production costs. We offer a new explanation for the observed differences that relates to behavioral aspects rather than demand- or supply-side effects. In particular, in a symmetric Bertrand duopoly laboratory experiment, for which theory predicts no differences between the two pricing regimes, we find that tacit price collusion is systematically higher under price discrimination than under uniform pricing.

Keywords: price discrimination, uniform pricing, multimarket contact, experimental economics, collusion

JEL: C92; L13
1. Introduction

When firms sell their products in more than one (geographic) market, they may either charge the same price across markets (uniform pricing) or they may charge differentiated prices according to the specific market conditions (price discrimination). According to conventional wisdom, firms should price discriminate whenever possible, due to asymmetric costs or differences in demand elasticity across markets. Although some exceptions to this conventional wisdom were identified (Dobson and Waterson, 2008), the existing literature agrees that price discrimination and uniform pricing generally yield different market outcomes when there are differences in the market conditions. On the contrary, there is currently no theory that predicts differences in market outcomes due to the two pricing regimes when there are no differences across markets.

In this note, we demonstrate in a laboratory experiment that price discrimination leads to higher average prices than uniform pricing even when firms and markets are symmetric. Thus, we identify a new explanation for differences in economic outcomes between the two pricing regimes that relates to their impacts on tacit collusion, rather than cost or demand asymmetries. Previous experimental studies on tacit collusion have not considered the possibility to price discriminate as a treatment variable (Engel, 2007).

In this context, our findings also relate to the literature on mutual forbearance (Edwards, 1955), which discussed the collusive effects of multimarket contact. Whereas under price discrimination the underlying markets remain, in principle, independent, uniform pricing creates a bond between the markets that effectively makes them one market. Porter (1980) argued that firms
meeting in several markets (price discrimination) may find it easier to tac-
itisely collude than firms meeting only in one market (uniform pricing). This

is because every colluding firm anticipates that a price deviation in any one
market will be punished by price cuts in all markets by the other firms. How-
ever, Bernheim and Whinston (1990) criticized this view and argued that a
rational price deviation should never occur only in one, but in all markets
simultaneously, thus rendering the multimarket retaliation as no more ef-
fective than the retaliation in a single market environment. Moreover, the
authors formally established an irrelevance result, which states that mul-
timarket contact cannot facilitate tacit collusion between symmetric firms
meeting in symmetric markets.\footnote{In their model, Bernheim and Whinston consider an infinite time horizon, whereas we consider a finite time horizon. However, note that collusion is harder to sustain with a finite time horizon (Harrington 1987) and thus, the irrelevance result remains to hold in the present context.} Hence, our findings can also not be ex-
plained by the mutual forbearance theory.

2. Experimental design

We consider an industry with two distinct markets, $A$ and $B$, in which two
symmetric, price competing firms, $i \in \{1, 2\}$, offer a homogeneous product
for $T$ periods, respectively. The supply of one unit of the product to either
market implies marginal cost of $c$ to each firm. The number of consumers
per market is $N$. Denote $i$’s price for market $X \in \{A, B\}$ by $p^X_i$. Then,
according to Bertrand competition, the demand of firm $i$ in market $X$ in
Each period is given by

\[ D_i^X(p_i^X, p_{-i}^X) = \begin{cases} 
N & \text{if } p_i^X < p_{-i}^X \text{ and } p_i^X \leq v \\
N/2 & \text{if } p_i^X = p_{-i}^X \text{ and } p_i^X \leq v \\
0 & \text{if } p_i^X > \min\{p_{-i}^X, v\},
\end{cases} \]

where \(-i\) is the index of the other firm and \(v\) is the consumers’ homogeneous willingness to pay. Consequently, \(i\)'s total profit in each period is

\[ \pi_i(p_i^A, p_i^B, p_{-i}^A, p_{-i}^B) = D_i^A \cdot (p_i^A - c) + D_i^B \cdot (p_i^B - c) \]

in case firms are allowed to price discriminate across markets. Similarly, if firms commit to uniform pricing, \(p_i = p_i^A = p_i^B\).

It is well known that the unique strict Nash equilibrium of the above Bertrand stage game is

\[ p_i^{A^*} = p_{-i}^{A^*} = \lceil c \rceil \text{ and } p_i^{B^*} = p_{-i}^{B^*} = \lceil c \rceil \]

under price discrimination, where \(\lceil \cdot \rceil\) returns the smallest feasible price level that is larger than its argument. Likewise, under uniform pricing

\[ p_i^* = p_{-i}^* = \lceil c \rceil. \]

Further, under reasonable assumptions about the equilibrium concept of the finitely repeated Bertrand game, the above unique equilibrium of the Bertrand stage game is also the unique price equilibrium of the repeated
Bertrand game. For example, Farrell and Maskin (1989) showed that the price equilibrium of the Bertrand stage game is the unique weakly renegotiation proof price equilibrium of the repeated Bertrand game. It is also the unique subgame perfect equilibrium. In conclusion, the theoretical prediction of both pricing scenarios is equivalent in terms of equilibrium prices and hence, in terms of profits and consumer surplus.

In the experiment, participants played $T = 10$ repeated interactions (periods) of the Bertrand stage game. Profits were accumulated over the periods. For a more direct relation between reward signals and participants’ decisions, the model was parametrized using EUR instead of an experimental currency unit. Marginal costs were set to $c = 30$ cent. Each market had $N = 10$ consumers with a willingness to pay of $v = 50$ cent each. The minimum price increment was chosen to be 1 cent. Treatments differed only with respect to whether participants could price discriminate (PD) or were restricted to uniform pricing (UP) between the two markets. As noted above, the unique strict Nash equilibrium entails that both firms choose prices $p^A^* = p^B^* = 31$ cent for both markets (treatment PD) or $p^* = 31$ cent as the uniform price (treatment UP) during all periods.

3. Experimental procedure

For each treatment condition, there were twelve sessions with four subjects each, i.e., 96 participants in total. The experiment was designed between subject, i.e., participants were exclusively assigned to one treatment condition. In total, each subject participated in three rounds. Each round consisted of ten consecutive repetitions of the Bertrand stage game, which we
refer to as *periods*. Within each round, there was a fixed partner matching. However, after each round, participants were matched with a new partner that they did not previously encounter. Thus, each subject played with all other participants of the same session for exactly one round (i.e., for ten periods). Since firms were designed to be symmetric, we avoided to label subjects in any order. Instead, a firm’s current partner was referred to as ‘the other firm’.

Every effort was made to ensure salience in the experiment. Participants were equipped with a calculator and the experimental software provided a forecast tool for demand and profit in the next round, given a subject’s expectation of both firms’ prices. Moreover, a history of previous prices within the same round and the same group was provided. However, there was no exchange of information or interaction between subjects in different groups, i.e., no population feedback \cite{Bruttel2009}. To avoid budget effects, the earnings of only one round were paid out. Participants threw a dice to determine which of the last two rounds was paid out to them. The first round, which was declared a practice round, was not relevant for the final payoff and thus, it is not considered in the subsequent statistical analysis. The experimental instructions provided to the subjects covered all stated design features of the experiment, including the number of periods and rounds as well as how the profits and their final payment would be determined.\footnote{The instructions as well as screenshots are provided in the appendix.}

The experiment was computerized using *z-Tree* \cite{Fischbacher2007}. All sessions were run at the Karlsruhe Institute of Technology in Karlsruhe, Germany, in May and June 2012, and April 2013. Participants were recruited.
via the ORSEE platform [Greiner 2004]. Subjects were exclusively students of economic fields. None of the 24 sessions lasted more than one hour. No initial budget was given to the participants. Subject’s average monetary earning was 10.86 EUR.

4. Results

We aggregate our data by computing the average market price over all ten periods of a round. Note that under price discrimination the average is taken also across markets. Thus, at the group level an observation is uniquely identified by treatment (UP or PD), session (1 to 12), group (1 to 2), and round (1 or 2). Thus, there are 48 observations for each of the treatments. However, note that due to our matching scheme, observations from a single session are not statistically independent. We control for this by means of a hierarchical mixed-effects regression model and by considering only the session-averaged market prices, respectively. First, however, in Table 1 we report the descriptive statistics with respect to a subject’s average price and profit, and a group’s average market price as a measure for tacit collusion. Moreover, Figure 1 shows the average market price for both treatments over

Table 1: Summary statistics.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Variable</th>
<th>Obs.</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>UP</td>
<td>Avg. price</td>
<td>96</td>
<td>40.45</td>
<td>4.75</td>
<td>31.80</td>
<td>50.00</td>
</tr>
<tr>
<td>UP</td>
<td>Avg. market price</td>
<td>48</td>
<td>38.74</td>
<td>4.92</td>
<td>31.10</td>
<td>49.70</td>
</tr>
<tr>
<td>UP</td>
<td>Subject’s profit</td>
<td>96</td>
<td>873.96</td>
<td>532.04</td>
<td>10.00</td>
<td>2,140.00</td>
</tr>
<tr>
<td>PD</td>
<td>Avg. price</td>
<td>96</td>
<td>44.50</td>
<td>5.06</td>
<td>34.45</td>
<td>50.00</td>
</tr>
<tr>
<td>PD</td>
<td>Avg. market price</td>
<td>48</td>
<td>42.89</td>
<td>5.84</td>
<td>33.10</td>
<td>49.60</td>
</tr>
<tr>
<td>PD</td>
<td>Subject’s profit</td>
<td>96</td>
<td>1,289.17</td>
<td>625.27</td>
<td>255.00</td>
<td>2,240.00</td>
</tr>
</tbody>
</table>
Figure 1: Average market price over time across treatments as a measure for tacit price collusion. The boundaries of the gray corridor depict the average of minimum and maximum market prices across markets for the price discrimination treatment.
the ten periods and contrasts them to the equilibrium price. Table 1 and Figure 1 already indicate two notable deviations from the theoretical prediction. First, prices have a positive offset from marginal costs, i.e., from the theoretical equilibrium. This is in line with previous experimental results on Bertrand competition (cf. Engel, 2007). Second, there seem to be differences in market prices and hence in tacit price collusion between the treatments. On average, the market price is 4.15 cent (10.71%) higher for the PD treatment.

In order to test for differences in the average market price between treatments, we consider the following two-level linear random-intercept model, which controls for the potential dependence of observations within one session:

\[ p_{ij} = (\beta_0 + \zeta_j) + \beta_{PD} \cdot PD + \beta_{\text{Round}} \cdot Round + \epsilon_{ij}, \]

where \( p_{ij} \) is the average market price of group \( i \) in session \( j \), \( PD \) is the treatment dummy, \( Round \) is a dummy for first or second payout relevant round, and \( \zeta_j \) is the error component shared between observations of the same session. Table 2 reports the results, which show that the average market prices are significantly higher for the PD treatment, whilst the round has no significant impact, i.e., there is no learning effect. Also by a one-tailed non-parametric Mann-Whitney-U test on session averages, the market price

<table>
<thead>
<tr>
<th>Covariate</th>
<th>Value</th>
<th>z</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>38.07</td>
<td>31.36</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>PD</td>
<td>4.15</td>
<td>2.58</td>
<td>0.010</td>
</tr>
<tr>
<td>Round</td>
<td>1.34</td>
<td>1.61</td>
<td>0.107</td>
</tr>
</tbody>
</table>
is significantly higher under price discrimination \((p = 0.0471)\). These findings suggest that the possibility to differentiate prices between geographic markets facilitates tacit price collusion more than uniform pricing. Hence, consumers’ surplus decreases in the transition from uniform pricing to price discrimination.

5. Conclusions

Contrary to existing theory, we find tacit price collusion to be significantly higher under price discrimination than under uniform pricing. This result offers the insight that even under symmetric market conditions the mere possibility to be able to engage in differential pricing may facilitate collusion and thus, lead to higher prices than price uniformity.

This result bears important policy implications. For example, competition policy may investigate more closely the impact on competition when firms switch from uniform pricing to discriminatory pricing. Furthermore, whether price discrimination should be allowed for different geographic markets is currently under consideration by many national regulatory authorities in the telecommunications domain. Currently, telecommunications operators are bound by a universal service obligation, which usually includes a uniform pricing constraint. In order to stimulate investments in so-called next generation networks, regulators are considering to move towards a geographically segmented regulation, which would imply the possibility for price discrimination.\(^3\) As our results show, such a relaxation of the pricing constraints

\(^3\)For example, recently the German legislator has explicitly enacted that a differentiation of retail prices in next generation networks is not abusive per se.
may also have unexpected consequences on consumers’ surplus and should therefore be closely scrutinized by regulators.

Of course, our results are subject to some limitations. Although our competition model is believed to be fairly robust to alternative theoretical explanations (e.g., other-regarding preferences, heterogeneous products), we only considered price competition. Thus, it might be worthwhile to investigate whether our empirical results would also hold in the context of quantity (Cournot) competition. Future work may also address the role of elastic demand, i.e., heterogeneous willingness to pay among consumers, which may alter the collusive strategy. Likewise, it would be interesting to see whether our results carry over to settings in which there are more than two firms or markets.

Acknowledgments

Financial support from the German Science Foundation (DFG) is gratefully acknowledged. We particularly thank the editor and an anonymous referee for valuable comments.


vs. uniform pricing. University of Warwick, Department of Economics. Mimeo.


