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CARTEL PRICING DYNAMICS WITH REFERENCE-DEPENDENT PREFERENCES

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Abstract

This paper characterizes cartel pricing dynamics when consumers have reference-dependent preferences. Firms' discount factor is firms' private information and in every period there may be an industry-wide cost shock. Consumers observe the price over time and update their expectations about firms being able to collude. This affects consumers' price expectations (the reference point). Reference-dependent preferences make consumers unwilling to buy at too high a price compared with their price expectations, which forces cartelizing firms to raise prices over time together with consumers' price expectations. This increasing price path is capped by the price arising when consumers are sure that firms collude.

JEL Classification: L13, L20, L41, D03.

Keywords: cartel pricing dynamics, reference dependent preference, discount factor uncertainty

1 Introduction

The analysis of the discovered cartels in the last decades has shown that, first, prices have a transitory phase during which they gradually rise and, then, they eventually remain constant. Harrington (2006) reports several examples, among which the citric acid and lysine cases (see also Connor, 2001), several of the vitamines cases (Levenstein and Suslow, 2001) and

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graphite electrodes cases (Harrington, 2004b). Harrington (2006) also provides examples of future planned gradual price increases, for the choline chloride and the carbonless paper cartels. These examples are for intermediate products, but there are also examples for final products: among them, the French mobile cartel[1], the Italian pasta cartel and the German coffee cartel.[2]

The theories addressing this question must show both that, first, prices rise gradually up to a certain level – they do not directly jump to the final collusive level – and, then, that they eventually become stable. Harrington (2004, 2005) and Chen-Harrington (2006) have developed theories addressing this topic. Harrington (2005) analyzes the impact of different antitrust policies on cartel price dynamics. He shows that when damage multiples are higher and the probability of detection is higher, the steady-state price is lower, but also that the level of fines does not alter it. Furthermore, a more competitive benchmark to calculate damages can increase the steady-state price. All the results are derived by assuming that the incentive compatibility constraints (ICCs) are fulfilled and slack. Harrington (2004) generalizes the results above by allowing the ICCs to bind. First, when they bind, the cartel may first raise prices and then decrease them towards the steady-state level, in order to maintain the ICCs fulfilled. Second, antitrust laws may have a perverse effect, as in some cases they allow the cartel to eventually price higher. This is due to the fact that the risk of being fined can stabilize a cartel and thereby allow it to set higher prices. Chen and Harrington (2006) explain the increasing price trend with the probability of being fined, which depends on the difference between past and present prices. This creates an incentive for raising prices slowly, in order to avoid fines. Buyers are assumed to become suspicious when they observe anomalous pricing.

The present paper proposes an explanation for this cartel pricing dynamics by assuming rational consumers. Building on insights from the behavioral literature, I assume that consumers have reference-dependent preferences (RDPs).[3] RDPs mean that consumers' utility depends on the comparison between the outcome and a reference point. Consumers have RDPs in the price dimension: price expectations directly enter their utility function. The higher the difference between the actual and the expected price, the higher the utility loss.

Evidence of RDPs is widespread both in the experimental and in the empirical literature. Thaler (1980) proposes this concept to explain why consumers often do not behave as consumer theory predicts. Kahneman et al. (1991) enumerate a number of biases that are not explainable by traditional economic theory, among which loss aversion[4] (a particular

[1] See http://www.autoritedelaconcurrence.fr/pdf/avis/05d65.pdf.

[2] See http://www.bundeskartellamt.de/wEnglisch/download/pdf/Fallberichte/B11-019-08-ENGLISH.pdf. This cartel served both final clients and bulk customers, like hotels and vending machine operators.

[3] Kahneman and Tversky (1979), Erickson and Johansson (1985), Winer (1986), Kahneman, Knetsch and Thaler (1991), Chi-Kin-Jim and Kalwani (1992), Rotemberg (2004), Koszegi and Rabin (2006), Ellison (2006), Heidhues and Koszegi (2008).

[4] Loss aversion means that sensitivity to losses (with respect to a reference point) is greater than to gains.

case of RDPs), providing a series of experiments. Kahneman and Tversky (1991) discuss other experimental evidence and propose a model based on loss aversion that explains these biases by a deformation of the indifference curves about the reference point. With empirical data, Bowman et al. (1999) show the existence of loss aversion in saving decisions, Genesove and Mayer (2001) in the housing market and Haigh and List (2005) among the professional traders. Novemsky and Kahneman (2006), Gill and Prowse (2012) and Allen et al. (2014) provide experimental evidence. Finally, Fox et al. (2007) investigate neural correlates of loss aversion and show that people typically exhibit greater sensitivity to losses than to equivalent gains.

Koszegi and Rabin (2006) and Koszegi and Heidhues (2008) build formal models on loss aversion. Koszegi and Rabin (2006) analyze consumer behavior with loss aversion and an endogenous reference point and show that, when the outcome is uncertain, the willingness to pay increases in the expected price, conditional on purchase. Heidhues and Koszegi (2008) use loss aversion to explain the existence of focal prices in a static game.[5] Koszegi and Rabin (2007), Macera (2009) and Gill and Stone (2010) consider dynamic games with loss aversion and endogenous reference point in consumption plans, labor contracts and tournaments, respectively.

In the present paper I develop an infinite-horizon game with an endogenous reference point that focuses on collusion. The basic ingredients are (i) the reference-dependent preferences and (ii) the uncertainty, on the consumers' side, over the firms being colluding or not.

Consumers update the reference point – the expected price in the current period – through the price they have seen up to that period. The reference point is based on the probability that firms, whose ability to collude is unknown to consumers, set a high or low price. There can be an industry-wide cost shock in every period affecting the competitive price.[6] Consumers see the price firms set in every period and update their beliefs over the firms being colluding. If the competitive price in the current period is "high", consumers update their beliefs by giving more weight to the possibility that firms are colluding. Thus, the larger the number of periods in which firms sets the high price, the more consumers become pessimistic about the competitiveness of the market and expect a higher price. This makes the reference point rise, which reduces the effect of RDPs and makes consumers willing to pay a higher price. This allows firms to actually raise prices, with a cap being the price that would take place if consumers were sure that firms are colluding.

This paper is organized as follows. Section 2 presents the model. Section 3 analyzes its robustness and concludes.

RDPs are a more general concept, as they simply assume a positive sensitivity to losses and gains.

[5] Focal prices consist of equal prices across differentiated goods, even if their production costs differ. Heidhues and Koszegi interpret the reference point as the consumers' "lagged rational expectation", which, since the setting is static, is exogenous.

[6] The model can be adapted to demand shocks without changing the main results.

2 Setup

Demand in period t is given by $D_t(\mathbf{p}_t, E[\mathbf{p}_t])$, where $\mathbf{p}_t$ is the vector of prices and $E[\mathbf{p}_t]$ is the expected vector of prices in t, given the information available up to the beginning of period t. Assume that demand is decreasing in $\mathbf{p}$ and in the difference $\mathbf{p}-E[\mathbf{p}]$. The latter represents the reference-dependent preferences. Denote $dD_t(\mathbf{p}_t, E[\mathbf{p}_t])/d(\mathbf{p}-E[\mathbf{p}]) = \lambda(\mathbf{p}_t, E[\mathbf{p}_t])$. The parameter $\lambda(\mathbf{p}_t, E[\mathbf{p}_t])$ – for simplicity λ – represent the importance of reference-dependent preferences: a high λ means that consumers lose a high utility when the actual price is higher than the expected one.

Firms have a common marginal cost equal to $\underline{c}$ or $\bar{c}$ which is drawn in every period. The current cost c_t is firms' private information and it is $\underline{c}$ with probability μ and $\bar{c} > \underline{c}$ with probability $(1-\mu)$.

Firms may be able to collude or not, depending on their discount factor. At the beginning of the first period the discount factor is drawn and it is firms' private information. Consumers do not know whether the discount factor makes collusion sustainable or not, but they can infer it from the firms' prices over time. The probability that the discount factor allows firms to collude is ρ.[7] Firms choose their price. Each firm i faces a demand equal to $d_{i,t}(\mathbf{p}_t, E[\mathbf{p}_t])$ and earn profits equal to $\pi_{i,t} = (p_{i,t}-c)*d_{i,t}(\mathbf{p}_t, E[\mathbf{p}_t])$. Assume that firms prefer *not* to clearly declare that they are colluding. The simplest reason may be the presence of an Antitrust Authority (AA) which can fine the cartel members.[8] The following subsection explains the timing of the game.

2.1 Timing

In $t = 0$:

1. The discount factor is drawn and revealed only to firms. The discount factor makes collusion possible with probability ρ.
2. Consumers form price expectation $E[p_{t=0}]$.
3. The marginal cost c is drawn and revealed to firms. It is $\underline{c}$ with probability μ and $\bar{c}$ with probability $(1-\mu)$.
4. Firms choose their prices.
5. Stage game payoffs are realized.

[7] We assume that when the discount factor allows firms to collude, firms actually collude.

[8] Another reason can be that consumers expect the price of competing goods, whose price they currently ignore, to be correlated with the prices they observe: firms would prefer to hide that they are colluding, in order to make consumers think that the price of the to-be-searched goods is high too, reducing their incentives to search for them.

In $t \geq 1$ all the steps are the same, except step 1 that disappears (the discount factor is drawn only at the beginning of the game). In every period consumers update their beliefs over ρ by observing the prices firms set.[9] Denote $\hat{\rho}_{t,\tau,\hat{t}}$ the consumers' belief that the market is collusive at the beginning of period t, after τ periods of "low" prices and $\hat{t}$ periods of "high" prices. "Low" and "high" prices are explained in the following subsection.

2.2 Price evolution

Denote the low price as $\underline{p}_t(\hat{\rho}_{t,\tau,\hat{t}})$: it is the competitive price in period t when the current cost draw c_t is $\underline{c}$ and the updated belief over ρ is $\hat{\rho}_{t,\tau,\hat{t}}$. Simmetrically, denote the high price as $\bar{\mathbf{p}}_t(\hat{\rho}_{t,\tau,\hat{t}})$: it is the competitive price in period t when the current cost draw c_t is $\bar{c}$ and the updated belief over ρ is $\hat{\rho}_{t,\tau,\hat{t}}$. The low and the high prices therefore depend both on the current expected price, which in turn depends on the updated belief $\hat{\rho}_{t,\tau,\hat{t}}$ that the market is competitive, and on the current cost draw. Of course, for each belief $\hat{\rho}_t$ we have $\bar{\mathbf{p}}_t(\hat{\rho}_{t,\tau,\hat{t}}) > \underline{p}_t(\hat{\rho}_{t,\tau,\hat{t}})$.

When firms collude they pretend they have high cost even when they draw a low cost. The main reason for this type of collusion is that firms are typically unwilling to clearly show that they are colluding. If there is an Antitrust Authority that can impose fines, the reason is clear. But even without an Antitrust Authority, firms may be unwilling to clearly show that they are colluding: for example, this may induce entry into the market (as the entrants expect supra-competitive profits), or make consumers search for alternative goods whose existence or price is not directly available to them. Under this type of collusion, in $t = 0$ consumers know that market price will be $\underline{p}_0(\rho)$ if the cost draw is $\underline{c}$ *and* firms do not collude. From the consumers' point of view, this occurs with probability $(1-\rho)\mu$. With probability $1-(1-\rho)\mu$, the price consumers see will be $\bar{\mathbf{p}}_0(\rho) > \underline{p}_0(\rho)$.

In $t \geq 1$, consumers update their belief about ρ given the prices they have observed up to that period. This leads to the following Lemma.

Lemma 1 *If consumers observe a low price in any period t, then $\hat{\rho}_{t,\tau>0,\hat{t}} = 0$. If they observe the high price during during t periods, the updated $\hat{\rho}_{t,\tau,\hat{t}>0}$ is*

$$\hat{\rho}_{t,\tau,\hat{t}} = \frac{\rho}{\rho + (1-\rho)(1-\mu)^t}. \tag{1}$$

Therefore we can simplify the notation of the updated belief $\hat{\rho}_{t,\tau,\hat{t}}$ to $\hat{\rho}_t$, which is the updated belief as long as consumers observe the high price during t periods and have never observed a low price. One can easily check that $\frac{d\hat{\rho}_t}{dt} > 0$. This Lemma explains how the belief $\hat{\rho}_t$ that the market is collusive evolves over time. This expectation is crucial, as it determines the price consumers expect to pay. In the equilibrium where firms collude and pretend to have the high cost (the "collusive equilibrium"), the expected price $E[p_t]$ is given by the following Lemma.

[9] For simplicity, since now on we simply call them "prices".

Lemma 2 *In the collusive equilibrium, the expected price in t is:*

$$E[\mathbf{p}_t] = (1-\hat{\rho}_t)\mu * \underline{\boldsymbol{p}}_t(\hat{\rho}_{\hat{t}}) + [1-(1-\hat{\rho}_t)\mu]\bar{\mathbf{p}}_t(\hat{\rho}_t) \tag{2}$$

The prices consumers expect to face are the low prices when firms do not collude, which occurs with probability $(1-\hat{\rho}_t)$, and have a low cost, which occurs with probability μ, and the high prices when firms collude or costs are high.

Proposition 1 *Combining (1) and (2), the expected price increases after a period with high prices, that is* $\frac{dE[\mathbf{p}_t]}{d\hat{t}} > 0$. *This makes firms gradually increase their prices over time.*

Every time consumers observe a high price, they give more weight to the probability that firms are actually colluding. This makes them expect to pay a higher price. In turn, that makes consumers lose less utility in buying the good. This makes firms able to actually charge them more over time. Eventually prices becomes more and more flat over time, as long as consumers observe high prices and become almost certain that firms collude. The cap on the expected price, and in turn on the actual price firms charge, is given by the following proposition.

Proposition 2 *Collusive prices are bounded from above by the price consumers expect when they are sure that firms are colluding:*

$$E[\mathbf{p}_t|\hat{\rho}=1] = \bar{\mathbf{p}}_t(\hat{\rho}_t=1) \tag{3}$$

This expression comes from (2) with $\hat{\rho}=1$. Prices therefore rise, at a slower and slower pace, until consumers become (almost) certain that firms are colluding. In the limit, prices are flat and the transition phase is over.

3 Conclusion

This model proposes an explanation for the cartel pricing dynamics through reference-dependent preferences and uncertainty over the firms' ability to collude. The gradual rise of prices is well known in the cartel literature and, up to now, the main explanations were based on the fear of antitrust fines. This paper provides an explanation based on consumers' tastes. Consumers dislike paying a price higher than the expected one and this can force firms to raise prices smoothly. When firms repeatedly set a high price, rational consumers become more pessimistic about the competitiveness of the market and the price they will pay. This makes them accept to pay more, as their utility loss due to reference-dependent preferences is smaller, which allows firms to actually charge higher prices. This process is capped by the price arising when consumers are completely sure that firms are colluding.

The setup presented is simple, as firms' costs can take only two values. If firms' costs can take more than two values (e.g. they are drawn from a continuous distribution), the gradual rise of prices and the cap would still remain. The difference would be that pretending to have the highest cost would make the price rise quicker. Extending the model by explicitly allowing the presence of an Antitrust Authority would not change the qualitative results either. For example, assume that there is an Antitrust Authority that opens an investigation if the belief $\hat{\rho}_t$ that firms are colluding is above a given threshold.[10] If the fine is sufficiently high, firms will prefer to induce a belief $\hat{\rho}_t$ just below the threshold. In the two-costs case, this requires setting a low price once in a while, while in the more general continuous cost case this requires firms to pretend to have some intermediate cost after the initial periods of high cost. This would make prices rise until the level corresponding to the belief that firms collude just below the threshold used by the Antitrust Authority. The qualitative features of gradual rise until a given point are unaffected.[11] Adding the feature of sticky prices to the two-costs case would change the feature of the indefinite price rise towards the cap and would make prices reach a stable level in finite periods.

This model addresses the issue of the dynamic reference point. The reference point here is endogenous. Koszegi and Heidhues (2008) show the effects of loss aversion in a variation of the Salop model (1979) to explain the rationale for focal prices in a static environment. Koszegi and Rabin (2006) analyze how loss aversion impacts purchase and working decisions, taking the rational expectation over outcomes as the reference point in a static environment. Koszegi and Rabin (2007) and Macera (2009) do consider a dynamic game with loss aversion, but in a different framework. This analysis is the first, to my knowledge, that deals with collusion and reference-dependent preferences. It provides an alternative explanation for the cartel pricing dynamics, in particular the gradual rise of prices until a constant level, with rational consumers.

[10] The threshold may be justified by a budget constraint of the Antitrust Authority, which makes it optimal for it to open investigations only in the markets where finding evidence of collusion is sufficiently likely. Assuming an Antitrust Authority which opens an investigation randomly, independently from the price firms charge or the belief that firms collude, could only convince firms not to collude (if the expected fine is suffficiently high), but would have no impact on price dynamics. If the probability of opening an investigation and/or the fine depended on the price pattern (say on the price difference between the current and the past period), we would be in a situation very similar to Harrington (2004a, 2005) and Chen and Harrington (2006), the only difference being that reference-dependent preferences would reduce the speed of the price increase further.

[11] The only difference with the two-costs case is that the presence of the Antitrust Authority and the continuous cost make prices *stop* at that level, while in the two-costs case prices tend towards the cap with smaller and smaller increases.

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