In this article, the author presents the game-theory model The Prisoner’s Dilemma in a pricing context to demonstrate logic-based tactics pricers can use in avoiding price wars. This model also effectively demonstrates two important pricing points: firms that realize their pricing actions affect the aggregate market’s profit potential tend to make more long-term profit than firms that practice predatory pricing tactics, and understanding the significance of interdependence in pricing strategies in relationship to competitors not only allows for more informed decisions but overall market sustainability. Curry W. Hilton is a senior pricing analyst at Wiglaf Pricing and economics lecturer at Elon University. He can be reached at chilton@wiglafpricing.com.

The ever-so-dreaded prisoner’s dilemma outcome achieved in most pricing wars can be avoided in some instances by applying games of coexistence. In particular, the Hawk-Dove game offers a unique result that fosters mutual benefit and healthy market competition. The value contributed by the Hawk-Dove model involves understanding the cost of waging a price war, the potential strategy-dependent profit realized, and the managerial security expressed.

The Hawk-Dove game is structured in a normal form representation in a duopoly setting with a strategy space of [Hawk, Dove] and profit as the sought after pay-off. More formally, the game can be written:

\[
G = \{\text{Firm}_1, \text{Firm}_2; \text{Hawk, Dove}; \pi_{F1}, \pi_{F2}\}
\]

The possible strategies employed by each firm are symmetric, where Hawk (Fight) refers to participating in a price war and Dove (Sharing) refers to maintaining price. The game assumes that playing a Hawk strategy ensures at least one player loses. The corresponding profits realized by each firm result from the intersections of each player’s strategy set. Payoffs understood are a function of the entire market profit, the cost incurred by participating in a price war, and the probability of strategy selection. The Hawk-Dove game in a normal form payoff matrix is modeled below.

The \( V \) and \( C \) in the game represent the entire market profit and cost of waging a price war, respectively. The game’s equilibrium relies heavily on the relationship between the market profit and cost of price war participation. We will observe two cases of \( V \) and \( C \) proportions and their resulting outcome.

**Case 1:** \( (V/2) - C \geq 0 \)

This basically infers that the entire market profit distributed symmetrically between both competitors will exceed or equal the individual firm cost of engaging in the price war. An example of this case could be \( V = 100 \) and \( C = 25 \). In this specific case, the normal form payoff matrix would be described in Figure 2.

The dominant strategy for each firm regardless of the strategy the competing firm selects is Hawk—or in other words: participate in the price war. Since both firms have Hawk as their best response, the outcome of the game will be [Hawk, Hawk] and each will receive $25. Clearly, the achieved outcome is not the most mutually beneficial. The Hawk-Dove game where the profit received by each firm in the market is greater than the cost of waging a price war, the prisoner’s dilemma result is realized.
Case 2: \((V/2) - C < 0\)

In this scenario the profit realized by each firm in the market is less than the individual cost of engaging in a price war. An example of this case could be \(V = 40\) and \(C = 25\). In this specific case, the normal-form payoff matrix would be described in Figure 3.

A dominant or dominated strategy is not present in the proposed game. The intersection of firm’s best response functions offers multiple Nash equilibria in the pure game. Further investigation supports a mixed-strategy Nash equilibrium according to the probability distribution of choosing a strategy and its complement.

We will continue with our stated values for \(V\) and \(C\) in Case 2. Deriving the expected value realized by each firm according to the probability of each employed strategy in relationship to the other firm’s strategy will offer a means of determining the optimal probability mix.

Assume \(p\) is the probability of a Hawk choice by one firm intersecting a Hawk choice by the other firm and \((1-p)\) is the probability of a Hawk choice by one firm intersecting a Dove choice by the other firm. The expected profit realized by the Hawk type and Dove type are derived below.

\[
\begin{align*}
\text{Expected Profit}_{\text{Choose Hawk}} &= -5p + 40(1 - P) \\
&= 40 - 45p \\
\text{Expected Profit}_{\text{Choose Dove}} &= 20(1 - p) \\
&= 20 - 20p
\end{align*}
\]

Setting the expected profits calculated above for choosing Hawk and Dove equal to each other, under an indifference condition, will offer the steady-state probability of Hawk vs. Dove interactions. In another perspective this probability can be viewed as the healthy proportion of Hawks to Doves in a market composition.

The probability of each firm choosing Hawk or the proportion of Hawks in the entire market in this example is 0.80. Therefore, the probability of each firm choosing Dove or the proportion of Doves in the entire market in this example is 0.20. Figure 4 below models the payoffs received by playing Hawk (Blue Line) and Dove (Red Line) against the probability of choosing Hawk.

Assuming symmetric payoffs, the mixed-strategy equilibrium declares that each firm expects to receive positive profits of $4 each. A firm changing their selection behavior away from the steady state probability will deteriorate market fitness and encourage more frequent strategy selection. In Case 2, the saddle points of the game are \([\text{Hawk, Dove}; \text{Dove, Hawk}; \text{MSNE}(p = 0.8)]\). In the pure game and sub-game, the equilibria offer solutions that avoid the prisoner’s dilemma outcome.

The importance of coexistence games rests on the promotion of sound market interactions even in the midst of irrational behavior. Firms that realize their pricing actions affect the aggregate market’s profit potential tend to make more long-term profit than firms that practice predatory pricing tactics. Understanding the significance of interdependence in pricing strategies in relationship to competitors not only allows for more informed decisions but overall market sustainability. Avoiding price concessions for the sake of market-share capture and strategically “sharing” market profit by effective and legal price communications improves healthy competition.