

## Optimal Timing of Cartel Formation Under Uncertainty

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# Optimal Timing of Cartel Formation Under Uncertainty

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## Introduction

Understanding and developing a framework for explaining why and how businesses form cartels is a difficult and challenging endeavor. When studying the optimal deterrence strategies for the antitrust authorities, Connor (2005) analyzed a firms'-decision-making process in forming a cartel or in joining an existing cartel by comparing the expected benefit of cartel formation  $E(B)$  to the expected costs related to it  $E(C)$ . He indicated a cartel is formed as long as  $E(B) > E(C)$  inferred using traditional Net Present Value (NPV) tools. However, NPV methods rely primarily on measuring the future streams of benefits and costs without much regard for higher moments of the distribution. Thus, in the presence of uncertainty about future streams and litigation costs, NPV may miss important dimensions that shape the issue. The decision to form or join a cartel is, at least, partially irreversible because the firm or its involved managers are exposed to litigation even after the cartel might be dissolved in the future. And because market demand and future profits are uncertain, firms are careful about the timing of their cartel formation decision. In this paper, we rely on the aforementioned irreversibility of cartel joining and on uncertainty to extend the work by Connor (2005). Specifically, we apply a real-options approach to examine the optimal decision rules regarding the timing of cartel formation leading to policy tools useful for antitrust agencies.

## Methods

In the domestic model,  $n$  symmetric firms produce a homogenous product and compete with each other in quantity in an infinitely repeated game. The firms have an option to form a cartel and exercise joint monopoly power on the market. The market demand is subject to some stochastic shock at each period which follows a geometric Brownian motion. The threshold demand is a function of several parameters (in Table 1). Comparative dynamics analysis is conducted on these parameters.

Parameters	Definition
$\alpha$	Expected Demand Growth
$r$	Interest Rate
$\lambda$	Expected Cartel Duration
$n$	Number of Firms
$a$	Coefficient in the Demand Function
$b$	Coefficient in the Demand Function
$K$	Natural Obstacle

Table 1. Parameters Used in the Domestic Model Simulation

In the international model, two symmetric firms producing homogenous products in country 1 and country 2 separately. Before the two firms enter each other's market, there is no international trade, firms face different demand fluctuations in their own countries. If they decide to enter each other's market, they both operate in the international market facing the same uncertainty. The domestic shocks follow geometric Brownian motion, and the stochastic shock on the international market also follows a geometric Brownian motion.

## Results

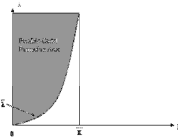


Figure 1. Range of natural obstacle ( $K$ ) and the expected cartel duration ( $\lambda$ ) for possible cartel formation.

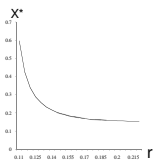
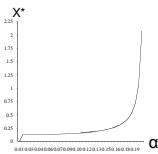


Figure 2. Threshold demand as a function of expected demand growth ( $\alpha$ ) and interest rate ( $r$ ).

- Cartel formation or operation is never optimal if the discounted expected value of collusion is less than the sunk costs associated with cartel operation or if the lifespan of cartel is too short for the benefits from collusion to cover the sunk costs (Figure 1);
- The cartel formation is more likely in economic boom periods;
- Cartel formation is delayed with higher sunk costs, a larger number of firms and more demand uncertainty, and it speeds up with longer cartel life and higher collusive profits;
- Cartel formation delays with a larger expected demand growth and speeds up with a higher discount rate (Figure 2);
- When there is a zero probability of cartel detection, the threshold level of demand associated with optimal timing of cartel formation under uncertainty exceeds the trigger demand level implied by the NPV method. And the difference between these two demand values increases with the market uncertainty;
- The expected social welfare under uncertainty is less than that under certainty.

## Results

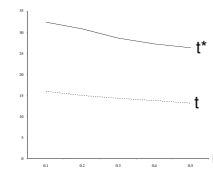
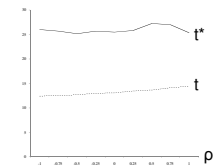
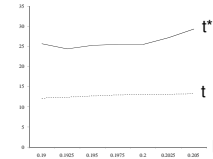


Figure 3. Expected times of optimal international cartel formation as a function of one country's demand growth, the correlation coefficient of the two markets and one country's market size. (Note: Dashed line represents the expected time without considering the alternative options and solid line represents the expected time considering the alternative options.)

- The expected time without considering firms' alternative options does not change much with the expected demand growth in country 1 ( $\mu_1$ ). But, the expected time of optimal cartel formation considering the alternative options is first decreasing and then increasing with  $\mu_1$ ;
- Firms have the most incentive to form an international cartel if the correlation ( $\rho$ ) between the two markets is close to 1;
- Both the expected time of optimal cartel formation is decreasing with the market size of country 1 ( $\eta_1$ ) with or without the alternative options. When the two markets have about the same size, the incentive to form a cartel is the highest.

## Conclusions

- Regarding the domestic cartel formation, cartel formation is never optimal for firms if the sunk costs are prohibitive or the lifespan of cartel is too short;
- The collusion threshold shows that firms would prefer waiting to form a cartel if there is a great uncertainty of market demand, a large expected long-term demand growth, a large number of firms, and a significant amount of irreversibility in the decision;
- Firms would shorten the waiting time in forming a cartel when collusive profit is high, the expected duration of cartel is long, and the discount rate is large;
- The expected social welfare under uncertainty is less than that under certainty;
- Regarding the international cartel formation, collusion is most likely to occur between firms that come from countries with highly correlated markets, similar expected demand growth and market size.

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