

New Brunswick Gasoline Industry: An Oligopoly Tacit Collusion Under Consistent Conjectures?

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This study develops a model that explains how a cooperative solution can be sustained in an oligopolistic industry (namely New Brunswick's gasoline industry) despite the inherently noncooperative strategies of the players, who are resolved to maximizing their individual (rather than joint) profits. The traditional Cournot-Nash assumption of zero (inconsistent) conjectural variation among oligopolists cannot adequately explain the gasoline industry in New Brunswick because its implication of an ongoing state of competition within an oligopoly industry has not been compatible with observed industry conditions. ⁽¹⁾ This study is motivated by a 1992 call (followed by another call in 1996) upon the New Brunswick government to regulate the gasoline retail industry in order to protect consumers from arbitrary price hikes by profit-seeking oil companies. The government replied that it wanted the market to be given a chance to regulate itself, and it feared that regulatory control would make the industry less competitive in the long run. This study will examine whether or not there is any economic basis for active government regulatory control or whether continued dependence on traditional market mechanism is preferable.

A leading research study on gasoline pricing in Canada (Blomqvist and Haessel 1978) concluded that retail prices at the pump were mainly influenced by the region of Canada under consideration, the tax policies of a particular Province, world crude-oil prices, and processing costs of the supplying refineries. Subsequent studies focusing on the competitiveness of the gasoline industry include that of Slade (1987), Restrictive Trade Practices Commission (1986), and Minister of Supply and Services Canada (1986). Slade's (1987) study revealed that some competition existed between two groups of gasoline retail outlets -- namely, brand-majors and independents -- involved in a noncooperative repeated game setting. While existing research findings on the issue have been generally inconclusive, Canadian Tax Foundation (1989) studies suggest that gasoline pricing has major feedback effects in the economy since the product has no close substitutes and permeates every aspect of production and distribution.

Thus, rising gasoline prices would have significant implications for inflation and unemployment.

To contribute to the ongoing research, with particular focus on New Brunswick, the paper will determine the nature and pattern of price competitiveness and stability among the oligopolistic competitors in the gasoline retail industry. It applies the framework of theoretic analysis to explain gasoline pricing in the context of oligopoly market rivalry in which a competitor's conjectural variation about rival moves is strictly non-zero with a probability of being either correct or incorrect. The analysis is used to determine whether gasoline pricing in New Brunswick is based on cooperative (quasi-collusive) or noncooperative (warfare) strategies, depending on whether or not rival conjectures about each others' moves and responses turn out to be certain. The question is whether the inherently noncooperative rival strategies could yield outcomes other than warfare.

The rest of the paper is organized as follows. In the next section, the standard oligopoly model utilizing Cournot assumptions is set out in order to demonstrate the difference which our application of non-zero conjectural variation is purported to make. Then the solution of the oligopoly problem under the assumption that all firms exercise consistent conjectural variations is considered. In this, the study develops and applies the concepts of "strategic manoeuvres" and "rivalry effects" to stress that cooperative solutions are possible (and likely) although the strategic interactions among firms is explicitly noncooperative. The next section presents the empirical analysis in the light of the theoretical model, followed by the summary and policy conclusions.

Oligopoly Conjectures

The gasoline industry satisfies the characteristic oligopoly interdependence among participating firms for which rival parties formulate their individual policies with "intent". ⁽²⁾ Strategic moves tend to draw rival responses that may precipitate either cooperative or noncooperative interactions. In the wide range of contributions made in the literature on this topic, oligopolists are posited to adopt dominant strategies within a nonconstant-sum game framework. The moves are noncooperative, and the solution is Nash equilibrium because of the myopic zero-conjectural variation disposition of the players in the game. However, each player achieves a relatively unsatisfactory payoff in such a warfare setting.

The Cournot-Nash Model of Inconsistent Conjectural Variation

The traditional Cournot zero-conjectural variation moves qualify as strategic moves within the broad definition of the concept (Bresnahan 1981). Assuming a general case where the output of each firm depends on the (market) output of the other firms in the industry, the basic presumption is that each competitor maintains conjectures (about strategic reactions of its rivals to its own) that are inconsistent (as each competitor takes its rivals' output decisions as unchanged irrespective of its own, and reckons that its rivals will either ignore its strategic moves or react in a certain predictable fashion).

This may be applied to the gasoline industry, assuming n firms, with inverse demand function: $p = p(Q)$, where p is market price, and Q is industry output defined as $Q = \sum_{i=1}^n q_i$, where q_i is firm i 's market output, $i = 1, 2, \dots, n$. Assume further that firms face similar cost conditions: $c = c(q_i)$, with the overriding objectives to maximize their respective profits:

$$\underset{(q_i)}{\text{Max}} \pi_i = q_i p(Q) - c(q_i) \quad (1)$$

The first-order conditions give the reaction functions:

$$\begin{aligned} & \cdot \\ & \cdot \\ & \frac{q_n dp}{dQ} (q_{n1} + q_{2n} + q_{3n} + \dots + q_{nn}) + p - \frac{\partial c}{\partial q_i} = 0 \end{aligned}$$

where

$$q_{ij} = \frac{\partial q_i}{\partial q_j}$$

The terms q_{ij} are the conjectural variation parameters. Under the apparently myopic assumption of zero conjectural variation, we substitute $q_{ij} = 0$ into the above, and obtain the reaction functions as:

$$\begin{aligned} q_1 &= f(q_2, q_3, \dots, q_n) \\ q_2 &= f(q_1, q_3, \dots, q_n) \\ q_3 &= f(q_1, q_2, \dots, q_n) \\ & \cdot \\ & \cdot \\ q_n &= f(q_1, q_2, q_3, \dots, q_{n-1}) \end{aligned}$$

Thus,

the reaction function is independent of the conjectural variation. This is clearly unrealistic because, by definition, a firm's reaction function must be a function of its conjectural variation. That is, a firm's profit maximizing output must be a function of the total output levels of its

rivals as well as the firm's belief about the reactions of those rivals to its own actions. Anything short of this would be inconsistent (Bresnahan 1981).

For this reason, the standard Cournot assumptions cannot adequately model the oligopolistic conditions of the gasoline industry in New Brunswick. We need assumptions that not only reflect that in equilibrium each firm exercises beliefs about the others' responses which are justified in the interim, but also that capture the essential aspects of consistency in a firm's perception of, and beliefs about, its rivals. We now turn to develop the model embracing this notion of consistent conjectural variation.

Consistent Conjectural Variation

Each firm sets out to maximize its own profit as indicated by equation (1). We assume the industry has a linear market demand curve: $p=p(Q)$, $dp/dQ<0$, $d^2p/dQ^2=0$. Further, we assume technology of linear cost functions, that is $c=c(q_i)$, $c/q_i>0$, $c^2/q_i^2=0$.⁽³⁾

Conjectures and reactions must be correct and consistent. Clearly, what an individual firm conjectures determines how it reacts to the moves of its rival(s). It is under this setting that each firm realizes the inherent interdependence between them, in that the profits of any one firm depend on the actions of the other firms.

Thus, because firms are likely to negatively affect each other's profits by their own actions, collusion of some sort must emerge. This collusion is likely to take the form of mutual recognition of acting in concert with each other. A full collusion solution of this problem would involve the maximization of joint profits:

$$\begin{aligned} \text{Max } \Pi &= \sum_1^n \pi_i \\ &= \sum_1^n q_i p(Q) - c_i(q_i) \\ &= Qp(Q) - \sum_1^n c_i(q_i) \end{aligned}$$

However, the oligopolists do not collude explicitly in this fashion. The type of cooperative (tacit collusion) solution being analyzed in the present study involves firms acting independently to maximize their respective profits under conditions of informed conjectures about their rivals. In such a setting, we explore the conditions under which an oligopolistic competition will result in a cooperative solution. Thus, each firm aims to maximize its profits given by equation (1). The first-order condition for firm i is given by:

$$q_i \frac{dp}{dQ} (q_{1i} + q_{2i} + q_{3i} + 1 + \dots + q_{ni}) + p - \frac{\partial c}{\partial q_i} = 0 \quad (2)$$

from which the reaction function for a typical firm with consistent conjectures is obtained as:

$$q_i = \frac{\partial c / \partial q_i - p}{(dp/dQ) [1 + \sum_2^n q_{ij}]} \quad (3)$$

Equation (3) gives the firm's reaction function in terms of its conjectural variation, and enables the introduction of the concepts of "strategic manoeuvres" and "rivalry effects" in oligopoly interactions. The former is a term for the slope of a firm's reaction curve, given by q_i/q_j ; it precisely measures firm i 's behaviour in responding to its rivals' output changes (a firm's disposition to react to rivals' actions). The rivalry effect (on firm i) is defined by the term Q/q_j ; it captures the market effects of rival actions and reactions whenever those rivals respond to firm i 's actions. The rivalry effect must be positive, therefore it gives an indication of the risks a firm takes in eliciting rivals' retaliatory (or otherwise) actions through its own actions at any time.

Denoting,

$\lambda = q_i/q_j =$ the strategic manoeuvre of firm i ,

$\mu = Q/q_j =$ rivalry effect,

then differentiating equation (3) with respect to q_j yields,

$$\frac{\partial q_i}{\partial q_j} = \frac{\frac{dp}{dQ} \left(\frac{\partial^2 c}{\partial q_i^2} \frac{\partial q_i}{\partial q_j} - \frac{dp}{dQ} \frac{\partial Q}{\partial q_j} \right) - \frac{d^2 p}{dQ^2} \frac{\partial Q}{\partial q_j} \left(\frac{\partial c}{\partial q_i} - p \right)}{\left(1 + \sum_2^n q_{ij} \right) \left(\frac{dp}{dQ} \right)^2}$$

This simplifies to

$$\psi_i = \frac{-\lambda \left(\frac{dp}{dQ} \right)^2 - \frac{d^2 p}{dQ^2} \lambda \left(\frac{\partial c}{\partial q_i} - p \right)}{\left(\frac{dp}{dQ} \right)^2 \left(1 + \sum_2^n q_{ij} \right)}$$

which, upon substituting $d^2 p/dQ^2 = 0$, yields

$$\psi_i = \frac{-\lambda (dp/dQ)^2}{(dp/dQ)^2 [1 + \sum_2^n \alpha_{ji}]} \quad (4)$$

Equation (4) shows that firm i 's strategic manoeuvre is a function of two key parameters that are central to oligopolistic interaction: one of which is related to the firm individually, namely, its (non-zero) conjectural variation, α_{ji} ; while the other relates to the industry as a whole, namely, the industry's rivalry effect, λ . Besides this, equation (4) also indicates firm i 's preconceived beliefs about its rivals' actions (including threats) in response to its own strategies.

Important strategic dispositions from the firm's standpoint can be derived from these results. It can be shown that:

$$\frac{\partial \psi}{\partial \lambda} = - \frac{(dp/dQ)^2}{(dp/dQ)^2 [1 + \sum_2^n \alpha_{ji}]} < 0, \quad (5)$$

and

$$\frac{\partial \psi_i}{\partial \sum_2^n \alpha_{ji}} = \frac{\lambda [(dp/dQ)^2]^2}{(dp/dQ)^2 [1 + \sum_2^n \alpha_{ji}]} > 0 \quad (6)$$

The sign of equation (5) suggests that under a given conjectural variation, a firm will scale down its strategic manoeuvre (that is, the firm will switch into a cooperative mode) if rivals adopt aggressive (noncooperative) modes. The sign of equation (6) suggests how a firm's strategic manoeuvre (disposition to react to rivals' actions) will be affected if and when the firm alters its conjectural variation. It shows that altering beliefs about rivals' strategies (due to, say, not taking their threats as credible or believing that their decisions would be less than rational), would lead the firm to revise its strategic manoeuvre in the same direction.

The foregoing results imply cooperative solution of the oligopolistic problem albeit under noncooperative strategies and amidst firms resolved to maximizing their individual (rather than joint) profits. It is viewed that, provided the firm's belief about its rivals' responses to any actions it takes are correct, it would not unilaterally deviate from the cooperative mode.

The question now is, would this cooperative strategy be the dominant strategy for each competitor, and under what circumstances? To find the answer we apply the standard

prisoners' dilemma model in order to shed light on the types of decision rules that may govern the choice of strategies that competitors' would be apt to adopt.

Resolving the Prisoners' Dilemma in a System of Finite Repeated Games

As a classic case of oligopoly market rivalry in which a competitor's conjectural variation about rival moves is strictly non-zero, the Prisoners' Dilemma model can be used to convey the central message of this study, namely, the use of the probability that each competitor's conjectural variation could be either right or wrong in devising long term strategic dispositions. This is particularly so where the conjecture is about whether or not rivals would act cooperatively. Moreover, the gasoline retail market involves a system where competitors can (and do) choose to either cooperate or not cooperate with rivals -- a system of a finite repeated game setting. For this reason, the prisoner's dilemma framework lends itself for elucidating the main theme of this paper. Specifically, it enables an application of a simple Bayesian comparative analysis of expected profits to explore what motivates competitors to either cooperate or not cooperate with their rivals.

We show that oligopolists would not choose the cooperative solution if they could not be more trusting of their rivals, and that such a trusting relationship must be necessary for any lasting cooperative outcome.

Firms are rational and know that their rivals are also rational, but not necessarily perfectly rational. Each competitor's conjecture about its rivals' moves is correct, but might be wrong. And this is because each competitor need not be perfectly rational (under circumstances of which its rival's conjectural variation would be wrong). The profit payoff of each competitor is given by .

For simplicity, we assume just two competitors: Firm 1 and Firm 2, each of who adopt either of the two strategies of cooperative moves (coop) with possible payoff 1 if rival adopts a similar strategy, or payoff $^{-1}$ (losses) if rival plays noncooperatively (noncoop). ⁽⁴⁾ Each player receives payoff 0 (indicating a bare breakeven condition) under a mutually aggressive (noncoop) play (a competitive warfare setting). A firm reaps payoff 2 should its rival play cooperatively while it plays aggressively. This payoff matrix is stated as follows:

		Firm 2	
		coop	noncoop
Firm 1	coop	Π_1^1, Π_2^1	Π_1^{-1}, Π_2^2
	noncoop	Π_1^2, Π_2^{-1}	Π_1^0, Π_2^0

Presumably, since the competitors are involved in their respective dominant (best) strategies, each having a profit level π_i^0 , if (and whenever) a competitor's conjecture is wrong, that competitor realizes profits $\pi_i^2 > \pi_i^0$ since its rival had failed to adopt the best strategy.

The expected value of payoffs over the relevant time horizon for a player adopting aggressive (non-coop) strategy, E_i^{nc} , is:

$$E\pi_i^{nc} = [\rho_i \pi_i^0 + (1-\rho_i) \pi_i^2]_1 + [\rho_i \pi_i^0 + (1-\rho_i) \pi_i^2]_2 + \dots \quad (7)$$

$$\dots + [\rho_i \pi_i^0 + (1-\rho_i) \pi_i^2]_{k-1} + [\rho_i \pi_i^0 + (1-\rho_i) \pi_i^2]_k$$

where

ρ_i = probability that firm i 's conjecture is correct,

π_i^0 = normal payoff under correct conjectures,

π_i^2 = payoff if conjecture is wrong,

and

$\pi_i^2 > \pi_i^0$,

$\pi_i^{-1} < 0$,

$i = 1, 2, \dots, n$.

Equation (7) gives the sum of current and future profits weighted by the conjectural disposition probabilities. For a player adopting an aggressive (non-cooperative) strategy that would result in warfare, the expected value of payoff would be less desirable than that obtained from a cooperative stance. The prospects of this outcome compels the competitor to adopt a cooperative stance in the game. However, a competitor's conjecture could be wrong (for example, its rivals may not really match its strategic moves in a tit-for-tat fashion), in which case the player comes off with a larger payoff π_i^2 . But since the game is a repetitive one, the player could be sure of the tit-for-tat reaction down the horizon should it play aggressively at any stage. It is this possibility that compels players to play cooperatively, resulting in a cooperative solution in an otherwise inherently noncooperative game setting.

The expected payoff from cooperative play, E_i^c , is

$$E\pi_i^c = [\rho_i \pi_i^1 + (1-\rho_i) \pi_i^{-1}]_1 + [\rho_i \pi_i^1 + (1-\rho_i) \pi_i^{-1}]_2 + \dots \quad (8)$$

$$\dots + [\rho_i \pi_i^1 + (1-\rho_i) \pi_i^{-1}]_{k-1} + [\rho_i \pi_i^1 + (1-\rho_i) \pi_i^{-1}]_k$$

A player's disposition at any stage of the game over time can be found by comparing E_i^{nc} and E_i^c at that stage. This is given by:

$$\begin{aligned}
 E\pi_i^{nc} - E\pi_i^c &= \rho_i \pi_i^0 + (1-\rho_i) \pi_i^2 - [\rho_i \pi_i^1 + (1-\rho_i) \pi_i^{-1}] \\
 &= \rho_i \pi_i^0 + (\pi_i^2 - \pi_i^{-1}) + \rho_i (\pi_i^{-1} - \pi_i^2) - \pi_i \prod_i^1 \\
 &= (\pi_i^2 - \pi_i^{-1}) + \rho_i (\pi_i^0 - \pi_i^1) + \rho_i (\pi_i^{-1} - \pi_i^2) \\
 &= \pi_i^2 (1-\rho_i) + \rho_i \pi_i^0 - \pi_i^{-1} (1+\rho_i) - \pi_i^{-1} > 0 \\
 &\text{since } \pi_i^{-1} < 0
 \end{aligned} \tag{9}$$

This indicates clearly that under a given probability of the correctness of a firm's conjectures about rival behaviours, ρ_i (that is, firm i is not certain about the direction of rival responses to its own behaviour), its expected payoff would be greater by adopting an aggressive play rather than a cooperative play. Therefore, the condition that ρ_i be an indicator of an ordinary chance event ($\rho_i < 1$) cannot explain the choice of cooperative solution among oligopolists. We must turn to an alternative condition surrounding ρ_i .

Cooperative behaviour among oligopolists, a quasi-monopolistic outcome, involves a degree of certainty among the players regarding each other's expected actions and reactions. This rules out the uncertainty of rivals' behaviour and therefore rules out the existence of the oligopolistic competition. This is to say that the probability of accuracy of firm i 's conjectures about rivals' behaviours, is one ($\rho_i = 1$). In this case equation (9) would turn out to be:

$$\begin{aligned}
 E\pi_i^{nc} - E\pi_i^c &= \pi_i^2 - \pi_i^{-1} + \pi_i^0 - \pi_i^1 + \pi_i^{-1} - \pi_i^2 \\
 &= \pi_i^0 - \pi_i^1 < 0
 \end{aligned} \tag{10}$$

This demonstrates that only if a firm has correct conjectures about rival actions is it profitable for it to adopt a cooperative play, under which it would have no incentive to deviate unilaterally. In fact, cooperative solution requires that the firm's conjectures be certain. A firm that opts out of the cooperative stance loses the certainty about rivals' responses ($\rho_i < 1$), and would have a lower (noncooperative) expected profit.

In practice, the extent of collusion between independent firms is limited by laws on restrictive practices. Clearly, this points to a policy question concerning the operation of the Canada's Competition Act under the Anti-Combine Laws. But if the profit gains from collusion are substantially high relative to the costs of operating the collusive agreement (including fines and any other types of punitive liabilities), then the companies have incentives to operate the collusive agreements. We shall turn to this question again in the empirical section below.

Empirical Analysis

As the above results indicate, the most congenial means by which oligopolists can be certain about their respective conjectures is to engage in tacit collusion. In this section, we verify whether the suggestion of a cooperative (quasi-monopolistic) situation emanating from the preceding theoretical analysis is supported by the empirical evidence existing in New Brunswick's gasoline industry. We try to infer the existence of tacit collusion among gasoline retail competitors as evidence of the underlying assumption of consistent conjectural variation among them. This would imply that competitors in this industry form their strategic decisions with due considerations to their respective strategic manoeuvres as well as the rivalry effects existing in the industry.

We present this analysis in two stages following, a brief background survey on the state of current research findings on the gasoline market in Canada as a whole. First, the random sample data is presented and used to analyze the industry's market shares and pricing trends over the decade. This is purported to reveal any unusual price uniformities that may not be explained by a kinked demand situation. ⁽⁵⁾ Second, the industry's concentration ratios are analyzed by constructing the Lerner Indices, a measure of market power, which is used to verify whether or not there is correlation between market power, market shares, and price uniformity. In all of these, the New Brunswick data is contrasted with control data on the neighbouring province of Nova Scotia to ensure that any characteristics that may be observed for New Brunswick are peculiar to the province.

Background Survey of Existing Research on Gasoline Market

We present the empirical study against the background of existing findings on the gasoline market in Canada. Retail gasoline is marketed through a network of service stations. These are grouped by:

the National brand majors: outlets operating under the name of a major company with national representation, such as Shell, Petro-Canada, and Imperial.

the Regional brand majors: outlets of other integrated oil companies having strong representation in only one or two regions of Canada, such as Irving oil, Sun oil, and Chevron.

Second brands: outlets owned and operated by fully integrated oil companies but not identified by the major brand logo. Included in this category are Shell's Beaver and Gas Mart (later sold by Shell), and Imperial's Gain oil and Econo oil.

Earlier empirical studies had suggested that there were aspects of spatial predation in gasoline pricing across Canada -- a strategy that is well suited for retail firms in a geographic market such as gasoline. ⁽⁶⁾

It was found that vertically integrated companies like Shell or Imperial Oil tended to introduce second-brand retail outlets as a way of restraining the pricing behaviour of independent competitors. This was done by locating the second brand outlets in the neighbourhoods of price-cutting independents and reducing prices in these second brand outlets, while maintaining higher prices at their primary-brand outlets.

A 1986 report by the Restrictive Trade Practices Commission (RTPC) argued that the vertically integrated petroleum companies used this practice of spatial predation to compete in the so-called discount-price segment of the gasoline market. ⁽⁷⁾ However, it appears that these companies were using the second brands to achieve at least two strategic purposes: to satisfy the price-conscious segment of the market demand (an aspect of price discrimination), and to deter entry and expansion of independent competitors. Thus, it does not seem that cooperative strategies were in place during the period.

Included in the report of the 1986 study are the following three findings that come very close to the principal focus of the present study: Canadians felt that the absolute level of gasoline prices were too high compared to prices in the United States (after adjustments are made for differences in taxes); pump prices were nearly identical for comparable grades at neighbouring stations, thereby giving no room for consumer choice; and, in those areas of the country where pump prices fluctuate, they tend to edge downward over some time and then suddenly increase very significantly within a very short while at all outlets. It appears that the first two findings are clearly true for New Brunswick.

In examining the determinants of market performance for a local retail gasoline market in Canada, Slade (1987) used a data set covering a three-month period over which a price-war existed within that market in 1983. The study implied that the outlets had some degree of cooperative play, under which they made higher profits. Further, it showed that they performed better (profit wise) than they would if they adopted noncooperative (unrepeated) strategies.

All the preceding evidence, though relating to Canada as a whole and not specifically to New Brunswick, are generally suggestive of quasi-collusive pricing. However, whereas stiff price competitions occur periodically in other provinces, they rarely occur in New Brunswick. Evidence of greater variance in prices in other provinces compared to New Brunswick can be

shown by the combination of greater frequencies of price wars and price vagaries across retail stations. Are the evidence suggestive of a more entrenched tacit collusion in New Brunswick on a scale that surpasses the other parts of Canada?

The Data

Following the results of a Canadian Automobile Association (CAA) 1993 survey which found that the question in the minds of most members is "why does gasoline cost so much" and "why are there so much price vagaries" across localities, we carried out a series of surveys using two stratified random sampling methods. The first was across the three major New Brunswick centres of Saint John, Moncton, and Fredericton. The surveys asked questions concerning the public opinion on gasoline prices and covered 243 respondents. The second was among New Brunswick, Nova Scotia, and Prince Edward Island gasoline stations selected at random. The surveys asked questions concerning their (observable) price levels, price-setting considerations, incidences of price-war, cost parameters, and the like -- a total of 42 stations in all were selected equally among the strata of various brand majors and independents in the various localities.

On the question of prices, 88% of consumers felt that gasoline prices were too high, and 67% of these felt that the high prices were deliberately set by gasoline companies in an effort to make higher profits 52% of those who believed that gasoline prices were too high agreed that the retail companies colluded to set the high prices.

Table 1 presents the analysis of the data we obtained on pricing trends across New Brunswick's gasoline stations over the decade 1983-1993. We use the price level of the Irving company as the base, and assign it the index of 100. ⁽⁸⁾ The data, therefore, depicts the degree of price deviations across the retail companies. Table 2 gives the corresponding trend for the neighbouring province of Nova Scotia, in which case the benchmark price is the price level of Esso (Imperial Oil Company) because of its relative dominant position there.

The New Brunswick data reveals evidence of identical pricing. While the price trends of Irving, Shell, Esso, and Ultramar were almost identical, there were upward price vagaries by the independents. Petro-Canada appeared to have played its traditional role of a price stabilizer up until 1990, after which it joined in the apparent price-fixing drive. The Nova Scotia data given in Table 2 shows something different. It suggests a degree of independent pricing that appears to be more aggressive.

To complement this evidence, and to determine whether or not the pattern observed in the price trends could be due to the kinked demand phenomena, 24 gasoline stations (four from each company) were surveyed in New Brunswick, and 16 were surveyed in Nova Scotia.

TABLE 1 Price Trends¹ in New Brunswick Gasoline Industry, 1983-1993

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	(Irving = 100)										
Irving	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Esso	100.1	99.9	99.8	100.0	100.0	100.0	100.2	100.0	99.9	99.9	99.9
PetCan	98.8	99.2	98.9	98.8	98.8	99.0	99.1	99.6	100.0	100.0	100.1
Shell	99.8	99.8	100.0	100.1	100.2	100.0	100.0	100.0	100.0	100.0	100.1
Ultra ²	100.0	100.1	100.0	100.2	100.0	99.9	99.8	99.9	100.0	99.9	99.9
Others	101.2	101.1	102.0	102.0	102.0	102.1	101.9	101.9	102.0	102.0	101.9

Note: 1. Unit price is per liter.
2. Formerly Texaco.

TABLE 2 Price Trends¹ in Nova Scotia Gasoline Industry, 1983-1993

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
	(Esso = 100)										
Esso	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Irving	101.1	101.1	101.0	101.0	101.0	101.2	101.2	100.0	100.0	100.0	99.9
PetCan	97.9	99.2	99.9	98.6	98.7	99.2	99.1	99.6	100.0	98.2	98.6
Shell	100.0	100.0	100.0	100.3	100.2	100.0	100.0	100.0	100.0	100.0	100.1
Ultra ²	99.9	100.1	100.0	99.9	100.0	100.0	100.1	99.9	100.0	99.9	99.9
Others	101.2	101.1	102.0	102.0	102.0	102.1	101.9	101.9	102.0	102.0	101.9

Note: 1. Unit price is per liter.
2. Formerly Texaco.

While 92% of the New Brunswick stations reported that they fixed their prices without the overriding purpose of matching or ignoring their rivals, 21% of the Nova Scotia ones reported that they fixed their prices without such considerations. Thus, 79% of the Nova Scotia companies stated that they engaged in price-matching and ignoring.

The striking thing, however, is that among the various companies, there

is the tendency to engage in price-matching and ignoring if located in Nova Scotia, while not so doing if located in New Brunswick; 80% of the stations who practised price-matching and ignoring in Nova Scotia stated that they would not be so aggressive if they were in New Brunswick.

Table 3 gives the data we obtained on the reported incidences or frequency of price-wars observed across major centres in the Atlantic provinces over the period 1983-1993. Over this ten-year period, most major centres outside New Brunswick reported far higher incidences of price-wars, ranging from a moderate frequency of 7 in St. Johns, Newfoundland, to a high of 28 in Halifax. This contrasts sharply with the very low incidences reported in New Brunswick's major centres of Saint John (3), Fredericton (5), and Moncton (6). The

TABLE 3 Gasoline Price War Incidences/Frequency¹ in Atlantic Provinces, 1983-1993

	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
St. Johns	0	1	1	0	1	2	0	1	0	0	1
Charlottetown	0	0	2	1	0	2	2	0	2	1	2
Halifax	2	2	3	2	4	2	3	3	2	3	2
Truro	1	0	0	0	1	2	1	1	1	0	1
Moncton	1	1	0	1	0	1	1	0	0	0	1
Saint John	0	0	1	1	0	1	0	0	0	0	0
Fredericton	1	0	0	1	0	1	1	0	1	0	0.9

Note: 1. Incidences/Frequency defined as number of events.

period before early 1990s seem to have witnessed greater incidences of price competition in New Brunswick's cities, while the 1990s saw reduced competition.

As one views the evidence so far, there is strong indication that reduced competition did set in later rather than sooner over the years. Could this be suggestive of government policy shifts over these periods? Has the weakening competition any links with the state of deregulation of the energy industry in New Brunswick? Did the deregulation of the late 1980s and early 1990s rather encourage collusive behaviour on the part of the retail companies? The evidence seems to suggest that the answers to these questions might be in the affirmative. However, we examine other evidence of collusive behaviour in the industry.

Concentration Ratios

The prevailing condition that can allow the gasoline companies greater leverages in collusive price-setting is the degree of market power that they exercise. In this section, we construct Lerner Indices of concentration measures for companies in New Brunswick and Nova Scotia, and use these to observe any existing differences that might be indicative of differences the market conduct between companies in the two neighbouring provinces. The Lerner index is especially useful for application in this study, as it is a measure of actual market conduct -- that is, the exercise of market power, rather than the mere existence of market power.

Tables 4 and 5 show the market shares and the calculated Lerner Indices of the gasoline retail companies in the two provinces. While the Irving company retains a leading market share of 30.4% in New Brunswick, it does not have a leading market share in Nova Scotia where it has a share of 20.8%

TABLE 4 Lerner Indices and Market Shares in the New Brunswick Gasoline Industry

Company	Market Share (%)	Lerner Index
Esso	26.2	0.493
Irving	30.4	0.561
PetCan	24.5	0.484
Shell	6.3	0.311
Ultra	10.1	0.368
Other	2.5	0.249

TABLE 5 Lerner Indices and Market Shares in the Nova Scotia Gasoline Industry

Company	Market Share (%)	Lerner Index
Esso	22.6	0.991
Irving	20.8	0.264
PetCan	27.2	0.306
Shell	8.1	0.168
Ultra	16.2	0.203
Other	5.1	0.142

below both Petro-Canada and Esso (27.2% and 22.6% respectively). ⁽⁹⁾

The Lerner index uses the unit retail price-cost margin expressed as a proportion of unit retail price to measure each company's market power leverage. The New Brunswick data shows that Irving has the highest degree of market power with an index of 0.561, followed by Esso with 0.494 and then Petro-Canada at 0.484. There is considerable correlation between the Lerner index and the market shares in this data, as would be expected. It shows that these companies individually have significant market power, and therefore can exercise significant leverages in collusive price-setting. This makes cooperative behaviour likely and profitable, as the evidence so far seems to indicate.

Conclusion

This paper began by using the standard notion of consistent conjectural variation of oligopoly firms to analyze how the fundamentally noncooperative stance of oligopolists would result in a cooperative outcome (*albeit* a Cournot-Nash equilibrium). Conjectural variation is posited as a probability of reckoning either rightly or wrongly, not only on the part of a given oligopolistic competitor but also on the part of their rivals, regarding each other's strategic moves and responses.

There is a tendency toward cooperative market behaviour among oligo-polist competitors because each has foresight, and correctly expects rivals to have similar foresight of its own strategic moves. Oligopoly firms are therefore less likely to adopt aggressive strategies that might lead to accelerated competition that thereby jeopardize chances of higher profits. However, if firms believe that rivals are less than perfectly rational (and such a belief turns out to be right), then they may resort to aggressive postures that result in noncooperative strategies and quasi-competitive outcomes of the usual Cournot solution.

Applied to the gasoline industry in New Brunswick, it is seen that the model adequately reflects the pattern of price setting and rival interactions among the oligopolist firms that are involved in the industry: each firm adopting a strategy that results in a cooperative solution in an otherwise inherently noncooperative game setting. The empirical analysis seems to bear evidence of a general tendency for price fixing at best, and outright tacit collusion at worse.

We have found that though the absolute level of retail prices of gasoline is too high in New Brunswick relative to other Canadian provinces, pump prices are nearly identical for comparable grades of gasoline. We have also found that even after such exogenous factors as the Provincial government's policies, taxation, cartelling, and consumer cooperatives are discounted, there do not appear to be gasoline price uniformity across the different regions of New Brunswick. Furthermore, we found that gasoline retail prices are unresponsive to

consumer demand. The above findings are sufficient to indicate that the gasoline industry is less than competitive in New Brunswick, and the high prices are largely due to this situation.

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Endnotes

1. Research for this article was funded by the University of New Brunswick Research Grant Competition Series 27. I thank John Baffoe-Bonnie and Professor William Milne for helpful comments. 1. Economists use the term conjectural variation to refer to the belief (conjecture) that each competitor has regarding how its rivals would react (vary) to its own unilateral actions and initiatives. The present study applies a model that assumes each competitor's conjectural variation to be a parameter: a model of parametric conjectural variation.

2. Intent, in this context, is strategic moves expressed by Schelling (1980) as a move designed to draw favourable rival responses. See Friedman (1986) for more details on strategic moves.

3. The assumption of linear cost functions is often made in industrial organization studies to simplify the analysis. Although relaxing this assumption and assuming rising marginal cost may not alter our purported results beyond complicating the solution of the model.

4. Playing cooperatively would imply restricting output and raising price (collusive market behaviour), while an uncooperative play would imply an aggressive flooding of the market with a large supply of output with drastic price reduction, given that $\alpha > 0$.

5. A kinked demand situation refers to a normal oligopoly competitive setting whereby firms match their rivals' price cuts and ignore their rivals' price increases. This would result in a relative price uniformity in the industry.

6. See Director of Investigation and Research (1981).

7. Although some of the earlier empirical studies suggested application of spatial models, such a model has not been considered in the theoretical section and is not envisaged in the present study. For a good coverage of such studies, see Slade (1987), or Jones and Laudadio (1977).

8. Irving is the largest and most prominent gasoline company in New Brunswick. It has the largest market share and enjoys relative, but by no means absolute, supremacy (in the sense that it has become a pace-setter, but not a dominant firm) among its competitors.

9. The Herfindahl index is also calculated from the data: for New Brunswick, $h = 0.236$; for Nova Scotia, $h = 0.204$. These results imply that the New Brunswick industry is more concentrated than the Nova Scotia industry, thus supporting the Lerner index calculations.

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