

Who is Doing What; to Prices?¹

Fatih Yilmaz²

Abstract:

Several different kinds of (vertical or horizontal) acquisitions have been closely monitored by anti-trust authorities in terms of market power although firms' contract positions, various strategic bidding behaviours in spot market or their output decisions are not well investigated. Findings of this paper show that the existence of a well functioning forward market in a symmetric equilibrium framework (as widely advocated in the literature) makes consumers better off although there is no reason to believe that firms will follow only symmetric equilibrium strategy in practice. Existence of profitable deviations from the equilibrium demonstrates that the equilibrium may not be stable in the long-run. As a result, one can conclude that forward contracts would certainly reduce market power if and only if who is contracting with who is not producer firms.

Key Words:

Forward Contracts, Electricity Markets, Regulating Electricity Markets

1 I would like to thank Professor Aidan Hollis for his great guidance which deserves most of the credits and all the shortcomings must be directed to me.

2 University of Calgary, Department of Economics, Social Sciences Building 618 Campus Place N.W. Calgary AB CANADA
e-mail: fyilmaz@ucalgary.ca

I. Introduction:

Many developed countries have been struggling to establish well functioning electricity markets since early 1990s to enjoy prospective benefits that could be extracted from only a competitive market system. However, transition from a government dominant market system to a competitively functioning market is not trivial. Very high fixed costs for new entrants, transmission constraints, different structures of market demand and supply and information asymmetries are only some of the difficulties that policy makers have to deal to prevent the possibility of exercising market power and assure competition in the markets.³ Mainly, (vertical or horizontal) acquisitions have captured a very close attention by anti-trust authorities in terms of market power whereas firms' contract positions, possible strategic bidding behaviours in spot market or their output decisions are in general not well investigated. In this paper, I study the strategic behaviour of firms in choosing their contract positions (in forward markets) and their bidding strategies (in spot markets) in a theoretical environment that is similar to Allaz and Vila (1993) and Bushnell (2006).

It is obviously not profitable for a producer firm bidding other than its marginal cost in the spot market if it had sold all its expected output via forward contracting. However, if the spot price is lower than its marginal cost, the producer may change its strategy by just reducing its output to avoid the higher marginal cost and purchase some of previously contracted amount from the spot market. In contrast, where the producer's real time production is below its contracted amount, there is also a strong incentive for firms to drive the spot market price below its marginal cost (as much as possible) to avoid possible losses from the forward obligations. Intuitively, it is profitable for a firm which has relatively less forward obligations to decrease its production in order to push the price up in the spot market due to many good reasons. As a result, there is no reason to believe that firms will follow only one strategy (which is generally assumed to be the symmetric equilibrium case in the literature) especially in the long-run.

Forward contracting is indeed an important tool to mitigate some of the market power although stability of the equilibrium (especially in the long run) also needs to be carefully examined to disclose possible leakages in the prevailing competition. Several models are considered in the paper to observe the firms' reactions in different market environments. Firstly, a monopoly model is considered for motivation and found that the monopolist is strictly reluctant to engage in any forward contracting unless it is forced to do so. This behaviour can be explained by the reduction in the market power coming from forward obligations. Secondly, duopoly models are constructed with different extensions by following static Cournot modeling approach⁴. It is observed that firms find it profitable to contract some of their outputs in the forward market. Furthermore, government intervention

3 MacCormack et al. (2008) outlines that there are several technical difficulties need to be accounted in electricity markets such as output cannot be stored efficiently and it depends on several constraints that are not controlled by producers such as wind speed, water levels in dams, price of fuel, etc. Also demand is very inelastic and changes according to time in a day.

4 Main assumptions of static Cournot models are homogenous products, market demand is linear, firms choose output, marginal costs are linear and identical and no entry barriers.

via lump-sum fashion does not actually affect firms' contract decisions. Finally, a deviation from the symmetric equilibrium with government intervention is considered where one of the firms is a net seller and the other is a net buyer in the forward market. Our findings show that the buyer firm may not supply all the output that it had accumulated from the forward market to derive the spot market price up while the seller firm is retarded due to capacity constraints. Consequently, the market price will be high and the output will be low which will have negative welfare results on consumers. Our policy proposal to authorities is to take precautions such as making sure that firms are not contracting among themselves but only with retailer firms. Alternatively, it could be the government or an authorized committee that could purchase all contracts available in the forward market and re-sell them in the spot market at a reasonable price.

In all models, firms' contract positions are assumed to be observable by other firms since observability matters as shown by Hughes and Kao (1997) in order others to react strategically. Also, no arbitrage condition is assumed that it basically imposes forward market price to be equal to expected spot market price which is a common treatment in the literature. Rest of the paper is organized as follows: Main models are discussed in the next section along with theoretical assumptions. Section 3 elaborates on the findings and also presents some comparative statics results. Finally, Section 4 concludes.

II. Allaz-type setting

II(i) *Basic model with a dominant firm*

Monopolists generally do not like regulations that target its market power and therefore, they will try any possibility to avoid such regulations. Hence, starting the analysis with a monopoly case will develop a clear understanding of the effect of forward contracting on firms' behaviour. In our case study, there is a single dominant firm as well as other fringe firms. As usual the monopolist maximizes its profit by determining the market price and the fringe firms take the price as given. Later on, I consider a basic government policy where it requires the monopolist to sell some of its output via forward contracting at the expected spot market price. As depicted in Figure 1, the market demand is assumed to be inelastic which must be a fairly realistic assumption for electricity markets⁵. To be more realistic, one can think of the fringe firms as being backup generators⁶. Basically, monopolist cannot charge infinite price otherwise, people would substitute to backup generators and produce their own electricity. P_{fr} stands for the price of fringe firms (or price for backup generators) and Q_m is the total monopolist's output that it supplies at the spot market price. Q_s and Q_d are total supply and demand. Finally, the market is clear at price P_{fr} .

5 Final electricity consumers do not observe any price change in the markets except the retailer price. Therefore retailers must engage in trade with producers to acquire the (strictly inelastic) demanded amount and supply it to consumers.

6 A backup generator has usually just enough capacity to supply electricity for one building which may work with gasoline or gas. Usually government and military buildings, hospitals or mills use such generators for emergency purposes.

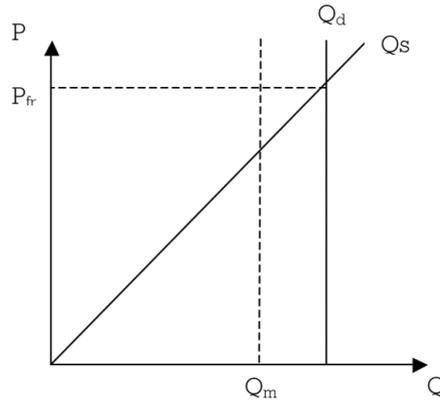


Figure 1: Market demand

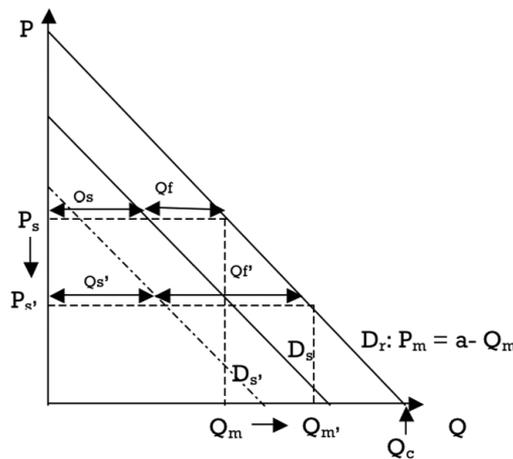


Figure 1: Market demand

After considering the fringe firms' supply, the residual demand curve for the monopolist becomes a downward sloping curve as shown in Figure 2. D_r is the initial residual demand curve, $P_m = a - Q_m$; D_s is the initial spot market demand (after forward contracting); P_s is the initial spot market price however due to no arbitrage condition, forward market price, P_f will be equal to the expected value of the spot market price, $P_f = E[P_s]$. The total supply of the monopolist is Q_m which is allocated between spot, Q_s and forward, Q_f markets⁷. Marginal cost of monopolist is also assumed to be zero. Finally, the problem of monopoly is to maximize (1) subject to its residual demand by taking P_f and Q_f as given and determine its total output, Q_m .

7 For clarification one can go through an exercise on Figure 2; if government increases the forward contract position requirement from Q_f to Q'_f then the market output will expand as well as the prevailing price in the market will decrease. In the extreme case where government requires the monopolist to forward contract all its output will force the monopolist to produce at the socially optimal output level Q_c where the market price will be equal to marginal cost which is zero.

$$(1) \quad \text{Max}_{Q_m} \{P_s(Q_m)(Q_m - Q_f) + (P_f Q_f)\}$$

It is straight forward to show that the total supply of the monopolist is $Q_m = (a+Q_f)/2$ by solving the FOC for Q_m . Furthermore, the optimum amount of forward contracting could be computed by substituting Q_m back into (1) and re-solving the argument for Q_f with no arbitrage condition assumption. Our algebra shows that the monopolist would not engage in any forward contracting and set $Q_f = 0$. In other words, the residual demand that monopolist can exercise market power shrinks as the contracted amount of output increases. As a result, setting forward obligation equal to zero is actually profit maximizing for the monopolist. Therefore, one might ask if government can use forward contracts as a policy instrument to decrease the market power of the monopolist. Since $Q_m = (a+Q_f)/2$ government can impose a certain forward contract position on the monopolist which will indeed increase the total output in the market and decrease the price. In the extreme case, government can require the monopolist to contract all its output which will eventually lead the monopolist to produce at the perfectly competitive output level, depicted as Q_c in Figure 2. As a result, the policy improves the welfare of consumers while decreasing profits of the monopolist which may not be sustainable due to very high fixed costs in the market.

II(ii) Strategic interaction with a cournot setup with no government

In this section, I expand the model to a duopoly market where there are two firms acting strategically in their output decisions that is basically a simplified version of Bushnell (2006). As before, the market demand is linear, (2). Firms are identical in terms of their production functions and also, their marginal costs are zero. The total output that firms produce are q_1 and q_2 which are the sum of forward and spot market outputs for each firm, (3). Finally, each firm faces with the profit maximization problem, (4).

$$(2) \quad P(q_1, q_2) = a - (q_1 + q_2)$$

$$(3) \quad q_i = q_i^s + q_i^f, i = 1, 2$$

$$(4) \quad \text{Max}_{q_i} \{(a - q_1 - q_2)(q_i - q_i^f) + (q_i^f q_i^f)\}, i = 1, 2$$

By rearranging the FOC, one can obtain the symmetric best response functions, (5). The FOC shows that the total output decision of firm i depends on its forward contract position (which is determined by the firm) and its rival firm's total output (which is taken as given). Intuitively, firms total output is positively correlated with their forward positions which demonstrates our argument that the forward contracting increases firms' total market outputs which implicitly means a reduction in firm's market power.

$$(5) \quad q_i(q_i^f, q_j) = \frac{q_i^f + a - q_j}{2}, \quad i, j = 1, 2; i \neq j$$

Solving (5) simultaneously for the symmetric equilibrium, the total output for each firm can be obtained as a function of their forward positions, (6).

$$(6) \quad q_i(q_i^f, q_j^f) = \frac{a - q_j^f + 2q_i^f}{3}, \quad i, j = 1, 2; i \neq j$$

$$(7) \quad \text{Max}_{q_i^f} \left\{ \left(\frac{a - q_i^f - q_j^f}{3} \right) \left(\frac{a - q_j^f + 2q_i^f}{3} \right) \right\}, \quad i, j = 1, 2; i \neq j$$

Following a similar procedure as in the monopolist case we can obtain the optimal level of forward contracts by plotting (6) into (4) which results (7) and then solving the optimization scheme for the optimal contract, q_i^f . The F.O.C is

$$(8) \quad -\frac{1}{3} \left(\frac{a - q_j^f + 2q_i^f}{3} \right) + \left(\frac{a - q_j^f - q_i^f}{3} \right) \frac{2}{3} = 0.$$

In a symmetric equilibrium as advocated in the literature⁸, the optimum amount of forward contracts is

$$(9) \quad q_i^f = a/5, \text{ where } q_1^f = q_2^f = q^f.$$

As the last step, we can solve for the optimum amount of total output to be supplied in forward and spot markets by substituting (9) back into (6) that yields $Q_m = 4a/5$ and $P_m = a/5$. Additionally, by using the price and firms' market supplies we can calculate their profits, $\Pi_i = 2a^2/25$ for $i=1,2$ given the assumption of zero cost. In contrast, it is worth noting that if we assume that there exists only a spot market (with no forward market existing) then the total market output decreases to $Q_m = 2a/3$ due to an increase in the price, $P_m = a/3$. This results higher profit levels for firms that is mainly because of the market power that firms are able to exercise in such an environment.

On the other hand if government allows only one of the firms to access the forward market then the equilibrium outcome will be in between two cases that are discussed above. For instance, if we assume that $q_j^f > 0$ and $q_i^f = 0$, as before, all the mechanical procedure will be the same until the FOC, (8); by solving (8) for optimal q_j^f , one can obtain $q_j^f = a/4$ and $q_i^f = 0$ from the equation. Hence, the total output of each firm is $q_j(q_i^f, q_j^f = 0) = a/2$ and $q_i(q_i^f, q_j^f = 0) = a/4$. Finally, the market output and price are $Q_m = 3a/4$

8 Firms are assumed to be identical and thus, their contract positions will be the same. Nevertheless, this assumption will be relaxed in the next section.

and $P_m = a/4$. This is quite different than the previous cases which represents an intermediate case. It is also trivial to calculate firms' profits which are reported in Table 1. Different regulatory approaches are considered in this section just to motivate our comparative statics discussion in subsequent chapters and obtain a clear understanding of the market mechanism. These exercises demonstrate that the more firms engage in forward contracts the less market power they can exercise or the higher the total output and the lesser the market price.

Yet, we have not considered a serious government intervention on firms' forward positions although it has been showed that even though there is no government intervention, firms would actually find it optimal to engage in forward contracts due to strategic interaction. Bushnell (2006) discusses a similar model with further complications such as N number of firms (instead of a duopoly) with a fixed cost consideration. Our model is kept quite simple to gain more intuition on firms' behaviour however one can easily incorporate further complications to account for different questions. Finally, this section concludes that the existence of well functioning forward markets induce market output, Q_m to be higher and the market price, P_m to be lower than the case where there is no forward contracting⁹.

II(iii) Strategic interaction with a cournot setup and government regulation

In this section, I build on the same basic cournot model as previously discussed in detail however now government requires all firms in the market to engage in a certain lump sum amount of forward contracting. In other words, the total contracted amount of output for both firms has two components as shown in (10). Firms determine q_{if}^f which I call voluntary (or privately) contracted amount and they take q_g^f , required contract position as given.

$$(10) \quad q_i^f = q_{if}^f + q_g^f, \quad i = 1, 2, \quad g = \text{government}$$

After considering the additional assumption (government regulation) in the model, the maximization problem to obtain the optimal level of forward contracts becomes (11). I skip the algebra for the first part of the maximization since the procedure for the first part is the same as (1) to (7). In (11), firm i determines its voluntary contract position given the requirement of government. As before, no arbitrage condition is assumed.

$$(11) \quad \text{Max}_{q_{if}^f} \left\{ \left(\frac{a - (q_{if}^f + q_g^f) - (q_{if}^f + q_g^f)}{3} \right) \left(\frac{a - (q_{if}^f + q_g^f) + (q_{if}^f + q_g^f)}{3} \right) \right\}, i, j = 1, 2; i \neq j$$

Solving (11) for the F.O.C. will result

⁹ See Table 1 for further details.

$$(12) \quad -\frac{1}{3}\left(\frac{a-(q_{if}^f+q_{ig}^f)}{3} + 2(q_{if}^f+q_{ig}^f)\right) + \left(\frac{a-(q_{if}^f+q_{ig}^f)}{3} - (q_{if}^f+q_{ig}^f)\right)\frac{2}{3} = 0.$$

After re-arranging (12) and solve for the optimal contract level by assuming symmetry in the voluntary contracts,

$$(13) \quad q^f = a/5 - q_G \text{ where } q_{if}^f = q_{jif}^f = q^f.$$

The algebra demonstrates that the total contracted output will be exactly the same as in the previous case where there was no government intervention, $Q_m = 4a/5$ and $P_m = a/5$. Both firms would decrease their voluntary contract level, q_{if}^f , $i=1,2$ for one-by-one in response to a lump-sum amount of forward contract requirement by government. As a result, there will be no change in the total output as well as in the market price. Of course this is only true if the required contract position is conducted via lump-sum fashion which does not change the slope of the residual demand curve but causes a parallel shift. Thus, we only need to worry about its direct effect where basically there is no price (or indirect) effect. On the other hand, this is also true if the government does not require any forward position greater than the firms' optimally (privately) preferred point. Without such assumption; if the contract requirement is higher than the optimum amount of forward contracts (that would be privately chosen by firms under no regulation case) then the voluntary contracted amount (q_{if}^f) will be negative. This could be interpreted as the firm is buying contracts of other firms in order to sustain the required contract position by the government. Finally, the net contract position¹⁰ remains same and thus the optimal amount of net forward contract position for each firm will be as shown in the previous exercise, (9).

A final remark is worth noting; our theoretical approach in this section resembles a very famous theorem that is constructed by Peter G. Warr (1983) in the context of provision of public good. The paper shows that people decrease their voluntary contribution to the provision of a public good for exactly one by one due to a (lump-sum) requirement imposed by government on people's contribution to the public good. This is certainly an important support to justify the theoretical frame developed here.

II(iv) One of the firms sells and other buys in the forward market with government regulation

In this case, I introduce further complications to the model discussed in the previous section. As before, we have two firms acting strategically. Additionally, now only one of them sells in the forward market and the other firm deviates from the symmetric equilibrium by purchasing all the forward contracts available in the market. To be more accurate, I assume that forward contract position of firm j is positive $q_j > 0$ (meaning that it is a seller) and the other firm's position is negative $q_i < 0$ (it is a buyer).

¹⁰ The term "net contract position" is used for q_{if} which is the sum of voluntary and the required amount of contracts.

This model is quite intuitive in capturing the possible negative effect of forward contracting that is reduces the competition in the market. Moreover, one of the firms initially contracts some of its output with the other firm (with the expectation of the other firm following the same strategy) while the other firm deviates from such strategy and buys all the output available in the forward market but does not sell any. As a result, the firm which purchased all the output in the forward market will enlarge its capacity and will be able to take advantage of having a bigger capacity than all previous cases while trading in the spot market. The leading assumption about information in this case is basically firms cannot see each other's contract positions until they finish negotiations in the contracting process. Therefore statically there is no change in the no-uncertainty assumption but dynamically firms cannot initially see each other's contract position while they are contracting and actually acting according to their expectations. One can think of this process as if firms declare their contract positions after completing their negotiations and signing the contracts.

As before, the total output of each firm is

$$(14) \quad q_i = q_i^s + q_i^f, \quad i=i,j.$$

The net contract position of firm j is $q_j^f = q_g$ (that is sold in the forward market where q_g is the initial required level of forward position by government from each firm) and by assumption, firm i does not sell any contract but buys all the output firm j sells in the forward market, $q_i^f = -q_j^f$. Thus the total output that firms can sell in the spot market becomes $q_i^s = q_i + q_g$ for firm i and $q_j^s = q_j - q_g$ for firm j . Finally we can model the profit maximization problem of the firms in the spot market as

$$(15) \quad \text{Max}_{q_i} \left\{ (a - q_i - q_j)(q_i + q_g) \right\} \quad \text{and} \quad \text{Max}_{q_j} \left\{ (a - q_i - q_j)(q_j - q_g) \right\}$$

Since all the contracted output is purchased by firm i , firms can supply retailers only through the spot market¹¹. Therefore, supply of the spot market will determine the total market output and price at the equilibrium for the final consumers. Solving (15) for the optimum output, q_i and q_j will lead

$$(16) \quad q_i = \frac{a - q_j - q_g}{2} \quad \text{and} \quad q_j = \frac{a - q_i + q_g}{2}.$$

One can solve (16) for the equilibrium level of total output given the regulated forward position, by substituting q_j into q_i . Hence, at the equilibrium the firms will produce $q_i = a/3 - q_g$ and $q_j = a/3 + q_g/3$. As mentioned earlier, the total supply in the spot market will be available to the retailers. Therefore, interaction of supply and demand in the spot mar-

11 This is because firm i purchased all the contracts supplied in the forward market and thus, retailer firms could not buy any output. Therefore, retailer firms will have to transact only in spot market to respond the demand of their (final) consumers.

ket will determine the market price. After recalling that $q_i^s = q_i + q_g$ and $q_j^s = q_j - q_g$; we can substitute $q_i = a/3 - q_g$ and $q_j = a/3 + q_g/3$ into these (former) equations and solve for the optimal spot market supply, (17) and the market price.

$$(17) \quad q_i^s = \frac{a}{3} \quad \text{and} \quad q_j^s = \frac{a-2q_g}{3}.$$

Following (17) the total market output will be $Q_m = 2a/3 - (2/3)q_g$ and the market price is $P_m = a/3 + (2/3)q_g$.

According to the model, profit of the firms depends on q_g which is the amount of contracts sold by firm j (or initial contract requirement of government). For instance, as in Case 5 (presented in Table 1) firm j sells $q_g = a/4$ and now let's assume that firm i buys all the contracts where the cost of production is again assumed to be zero for both firms. Thus the total output and price in the market will be

$$(18) \quad Q_m = \frac{2a}{3} - \frac{2}{3} * \left(\frac{a}{4}\right) = \frac{a}{2} \quad \text{and} \quad P_m = \frac{a}{3} + \frac{2}{3} * \left(\frac{a}{4}\right) = \frac{a}{2}.$$

It is worth noting that the prevailing price in the forward market was initially $a/4$ due to no arbitrage condition and firms' expectations. We call this deviation scenario as "naïve strategy" where one of the firms follows the symmetric equilibrium expecting the other firm to do the same although the other firm deviates from the equilibrium and buys all the contracts available in the market to take advantage of its forward position in the spot market. Therefore, the forward market price is $a/4$ however due to the deviation from the equilibrium and exercising market power in the spot market drives the prevailing price up in the spot market¹². Finally, their profits could be computed as

$$(19) \quad D_j = \frac{a}{4} * \frac{a}{4} + \frac{a}{6} * \frac{a}{2} = \frac{7a^2}{48} \quad \text{and} \quad D_i = \frac{a}{3} * \frac{a}{2} - \frac{a}{4} * \frac{a}{4} = \frac{5a^2}{48}.$$

Profits are higher for both firms than Case 5 that is reported in Table 1. Moreover, D_j is the profit of firm j . First part of it comes from the sales in the forward market and the second part comes from the sales in the spot market at the new price, $a/2$. This result shows clear evidence that there is a strong incentive for (both) firms to deviate from the symmetric equilibrium. Similarly, one can obtain the profit of firms by following the same procedure for Case 3 (no regulation case) which will result $\Pi_j = 21a^2/225$ and $\Pi_i = 26a^2/225$.

12 One might think that this should not be the case since we deliberately assume no arbitrage condition (forward market price being equal to the expected spot market price). Intuitively, we consider a deviation in this section where the no arbitrage condition prevails in the forward market while the firms contract their outputs although one of them deviates from the equilibrium strategy and purchases all the contracts in the market. Thus, deviating firm may find it profit maximizing to not to supply all its output in the spot market to derive the market price up while due to capacity constraints, it may not be possible for other firms to derive the market price back to its expected level. In short there is no violation of "no arbitrage condition".

The results of this section could be summarized as firm j increases its forward position, the other firm would be happy to purchase it since such transaction will eventually provide some market power to firm i (buyer firm). This is actually true only if there are capacity constraints (especially in the short-run). Basically, because of the constraints, firm j cannot compensate the reduction in the total market supply that is performed by firm i to derive the market price down. In order to keep the algebra simple I did not introduce any capacity constraint in the maximisation problem however I did implicitly assume that such condition is satisfied.

III. Elaborating on Results

In this section, I summarize the findings of all the models in Table 1 to compare their results in terms of the total market output and price. This will allow us to infer a comparison about possible market power that firms can exercise in such environments. Case 1 refers to the monopoly consideration. Not surprisingly, the total market supply is very low and the price is at its highest possible level. It is worth emphasizing that the monopolist would not engage in any forward contracting if it is not forced to do so as it clearly can be seen in Case 2. In Case 2, government imposes a forward contract position on the monopolist via lump-sum fashion.

Table 1: Market Demand and Price according to Forward Contracting Position

	Case 1	2	3	4	5	6	7
	Monopoly		Duopoly				
	With/O F.C	With F.C	With F.C (symmetric)	With/O F.C	With F.C (only one)	With F.C (government)	With F.C (government & one seller)
$q_{1-(i)}$	-	-	$2a/5$	$a/3$	$a/4$	$2a/5$	$a/3$
$q_{2-(j)}$	-	-	$2a/5$	$a/3$	$a/2$	$2a/5$	$a/3 - (2/3)q_g$
$q_{1r-(i)}$	-	-	$a/5$	-	-	$a/5$	$-q_g$
$q_{2r-(j)}$	-	-	$a/5$	-	$a/4$	$a/5$	q_g
Q_m	$a/2$	$(a+Qf)/2$	$4a/5$	$2a/3$	$3a/4$	$4a/5$	$2a/3 - 2/3q_g$
P_m	$a/2$	$(a-Qf)/2$	$a/5$	$a/3$	$a/4$	$a/5$	$a/3 + (2/3)q_g$
Π_i	-	-	$2a^2/25$	$a^2/9$	$a^2/16$	$2a^2/25$	-
Π_j	-	-	$2a^2/25$	$a^2/9$	$a^2/8$	$2a^2/25$	-
Π_r	-	-	$4a^2/25$	$2a^2/9$	$3a^2/16$	$4a^2/25$	-

In response to that, the monopolist increases the market supply which leads the market price to decrease. Such policy decreases the market power of monopolist dramatically. However forcing the monopolist to produce at the socially desirable output level (where $P=MC$) is mathematically possible; it may not be sustainable in the long-run due to high fixed costs.

Duopoly models are more intuitive in terms of observing the strategic behaviour of firms. I consider five interesting models where they all have different results except one. Case 3 is considered as a benchmark model where both firms can free forward contract without a government intervention. The findings show that firms would find it strategically optimum to sell a positive amount of output in the forward market. This is actually not new in the literature since it was initially showed by Allaz and Vila (1993) and further demonstrated by Bushnell (2006). As a result, the market price will be lower and total output will be higher compare to the case where there is no forward markets as discussed in Case 4. Furthermore, I consider an intermediate situation in Case 5 where there is a forward market however only one of the firms can access the market. Due to such restriction, the market output is low and the price is high relative to the benchmark case. Considering all the cases from 1 to 5, my findings do match with the literature and provides further evidence to support the idea that forward markets lead to a better competition. In addition to that firms' accessibility to forward markets is also as well important as the existence of such markets.

I incorporate two possible interesting regulations in cases 6 and 7. There are several reasons for government interventions such as government may want to assure a certain level of output (or may be the average market demand) supplied by the firms. In case 6, I impose a required (or regulated) level of forward contract position for both firms and found that as long as the requirement is in lump-sum fashion and also, lower than the privately optimal amount of contracts, firms would decrease their voluntary contracted amount for one-by-one. Therefore, the net forward contracted output and the market price do not change relative to benchmark model.

Finally, in Case 7 "naïve strategy"; the main assumption is the deviation from the symmetric equilibrium where firm j sells as before (in Case 5) but now firm i is willing to buy all the contracts in the forward market at the prevailing equilibrium price in the forward market. The result is quite striking in the sense that such policy leads to a market failure and reduces the competition. Profits of both firms are higher under case 7 than they were under Case 5 which provides strong evidence that there is strong incentive for both firms to deviate. Furthermore, one can easily go through a similar exercise by assuming Case 3 as the initial state which will also give similar results. However, the profit margin decreases if we had started from Case 3 instead of Case 5. This means, as the forward contracted amount of output increases (as in the initial case which could be thought as government's regulated forward position) firms' net profits decrease. This is actually a good news for policy makers since it will not be profitable for firms to contract all of their outputs to other firms. In another word, firm i (deviating firm) will not find it optimal to buy all the contracts if the amount that is supplied in the market is above a certain limit. There are mainly two lessons to be gained from the last two exercises: First, it is very important to know who is buying the contracts as well as having a forward market and secondly, regulations on forward contracting do not disturb the equilibrium as long as they are not higher than privately optimum level of contracts.

IV. Conclusions

Several models are presented in this paper to account for different policy options that could be considered by anti-trust authorities. Theoretical results of this paper solidify that the existence of a well functioning forward market would certainly mitigate some of the market power of the firms. However, efficiency in forward markets is as well important as its existence such as all firms should have frictionless access to the market and there should be no information asymmetry.

In general, firms would profitably engage in forward contracts due to strategic interaction that will lead to a higher market output at a lower market price as demonstrated by this and other papers in the literature. This paper takes further steps and shows that government intervention may fail to produce more desirable market outcome (such as more competition in markets) by imposing a certain forward position. However, the good news is that it at least does not hurt the market since there was no change in the market price and output as long as the regulated forward position is not far beyond firms' privately optimum level.

Another very important result derived by this paper is the equilibrium with forward contracts may certainly not be stable in the long-run. It could be a middle company, firms or a speculator gaining market power by basically purchasing all the contracts in the forward market and reducing the total supply in the spot market. The striking outcome from such case is that the seller firm (in the forward market) is also happy with the deviation of other firm since its profit is also higher than both firms following the symmetric equilibrium. Nevertheless, the good news is that the level of output available in the forward market influences the final profits in the spot market. For instance, contracting total output does not necessarily provide higher profits at high level of output supplied in the forward markets therefore such incentive disappears as the number of contracts supplied in the initial state increases. Finally, to overcome such problem; government could be the ultimate buyer of the contracts and sell them back in the spot market at a reasonable price or one way or the other; government must assure that producer firms do not trade contracts among each other but with only retailers. Otherwise, the equilibrium may not be sustainable in the long-run and many other failures might become present due to such problem.

References

Articles:

- Allaz, Blaise and Jean-Luc Vila (1993). "Cournot Competition, Forward Markets and Efficiency," *Journal of Economic Theory*, 53(1), February, pp. 1-16.
- James Bushnell, "Oligopoly Equilibria in Electricity Contract Markets" (August 29, 2005). Center for the Study of Energy Markets. Paper CSEMWP-148.
<http://repositories.cdlib.org/upei/csem/CSEMWP-148>.
-

J.S. Hughes, J.L. Kao (1997). "Strategic Forward Contracting and Observability". *International Journal of Industrial Organization*. 16, pp. 121-133.

Warr, P. (1983) The Private Provision of a Public Good is Independent of the Distribution of Income, *Economic Letters* 13: 207.211.

Working Papers:

J.R. MacCormack, H. Zareipour, W.D. Rosehart (2008). "A Reduced Model of the Alberta Electric System for Policy, Regulatory, and Future Development Studies". IAPR Technical Paper Series, TP-08004

Web sites:

Government of Alberta- "Utilities Consumer Advocate Official Web site". <http://www.uca-helps.gov.ab.ca/4.html> (accessed February 17, 2010)