Nash bargaining and renegotiation with social preferences: case of the roundwood log supply contracts in the French timber market

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ABSTRACT

By considering the French forest-based sector, we study both negotiation and renegotiation between a public timber and roundwood log supplier, which can be either public-interest-oriented or profit-maximizing, and a profit-maximizing lumber manufacturer. We first prove that the Nash bargaining game yields a unique equilibrium log supply contract, at which the negotiation takes only place on the prices. We then find that the expected profit-maximizing is achieved when the supplier's public interest and the manufacturer's bargaining power are strategic substitutes. The renegotiation reveals the presence of a memory effect over the quantities issued from bargaining. Our results can be generalized to all economic settings that revolve around public interest and commodity risk management.

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1. Introduction

As pointed out by Lewis and Bajari (2011), the public sector procurement corresponds to 15% of world output, such that designing efficient mechanisms for procurement is essential for guaranteeing the efficient allocation of goods. Auctions and bargaining are two popular examples of supply mechanisms. There is already an abundant theoretical literature on optimal procurement (Laffont and Tirole, 1987; Che, 1993, 2008; Manelli and Vincent, 1995; Branco, 1997; Asker and Cantillon, 2010; Lewis and Bajari, 2011), which is acknowledged to be a multi-factor process.

Bargaining is when the supplier and the buyer negotiate one at a time, whereas in auctions the buyer can play suppliers off against one another (Asker and Cantillon, 2010). It is recognized that bargaining allows for more flexibility than auctioning, at a cost of lower competition. It has received great attention from the economists (Nash, 1950; Binmore et al., 1986; Bulow and Klemperer, 1996). For example, in the five forces industry analysis by Porter

(2008), the bargaining power of the supplier affects the competitive environment and influences the manufacturer's ability to achieve profitability.[1]

In the public sector, most of the focus has been assigned to employee bargaining (Falch, 2001). To our knowledge, despite the literature on collective bargaining, there is no paper dealing with Nash bargaining between a public agent and a private agent, when both are programmed to maximize their payoffs. Summers (2003) explains that private sector depends on private parties shaped by market forces, whereas the public sector is shaped by public decisions which depend on political processes and market forces.

As of renegotiation, few economists have dealt with the topic. Coase (1937) claimed that the inefficiencies of adapting contracts to the changing environment drove the transactions within firms and by markets. Recent papers have mainly focused on the renegotiation inefficiency (Hart and Moore, 2008; Herweg and Schmidt, 2013), given that the standard framework assumes renegotiation

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[1] The link between the Porter framework and bargaining has previously been discussed by Brandenburger and Stuart (2007).

as efficient. Unlike previous models, we consider that renegotiation takes place after the supply contract has been established. In this context, the activation of the memory of the decision makers and negotiators is of great importance (Curşeu and Schruijer, 2008). Put differently, memory effects could provoke the anchoring to past information (Bazerman et al., 1985; Kristensen and Gärling, 1997).

To justify our research questions relative to the soundness of public-private profit sharing through bargaining, the consideration of the French forest-based sector proves to be particularly suitable. The upstream forest-based industry is composed of forest owners and managers, who not only manage forests, but also commercialize standing timber[2] and roundwood logs,[3] and of sawyers or lumber manufacturers, also known as the first processing subsector, who transform logs into lumber[4] and commercialize it to lumber remanufacturers.

The timber issued from the French public forests, managed and marketed to sawyers by the French National Forestry Office (ONF), which amounts to 40% of the whole domestic market volume, is currently sold through (1) auction sales, (2) over-the-counter sales and (3) long-term log supply contracts, the latter being strongly promoted by the French authorities (ONF, 2013). Several objectives have been assigned to the log supply contracts: to solve the issue of forest under-harvesting by planning fixed harvesting over several years; to allow access to the resource to the greatest number of manufacturers; and to structure the segmented French forest-based sector. In the past, the French Forest Code used to stipulate that the sales of public timber be on standing timber and by public auctions exclusively. The multiannual log supply contracts have been developed since a 2001 legislative reform and removed the derogatory nature of the over-the-counter sales. They can be annual or pluriannual, and cover the concepts of species, length, quality, volume and price. Following the negotiation process, they provide for the provision of roundwood logs purchased at several fixed dates. Based on the timber market evolution, the repricing is allowed during the contract life-time.

Inasmuch as the lumber manufacturers have access to the auction sales of the standing timber and the over-the-counter log sales, why should they have any interest in negotiating bilateral pluriannual roundwood log supply contracts with a public supplier? For example, contract price reductions have been enacted to improve the attractiveness of log supply contracts in comparison to other marketing channels, as well as to enable sawyers in financial difficulties to purchase their production inputs.[5] In this case, how should the supply contracts be adjusted via renegotiation depending on market conditions? From the foregoing, our will is thus to understand how the mosaic of supply sources, weighted by social preferences, shapes the competitive structure of the French timber industry.

Following the model by Dong and Liu (2007), we consider two economic agents that negotiate according to the Nash bargaining game. We study negotiation and renegotiation between an agent that can be either a public-interest-oriented or a profit-maximizing timber and log supplier and a profit-maximizing lumber manufacturer. We therefore introduce social preferences into the maximization program. Provided that the supply contracts belong to the family of forward contracts, which have originally been designed to reduce the exposure to cyclical risks, we endow the agents with mean-variance utility functions.

We first prove that the Nash bargaining game yields a unique equilibrium log supply contract, at which the negotiation takes only place on the prices. The roundwood log supply contracts are suitable for both agents when they permit reducing the profits' variances which are expected to be positive.[6] We find that the expected profit-maximizing is achieved when the supplier's public interest and the manufacturer's bargaining power are strategic substitutes. As for the renegotiation, it reveals the presence of a memory effect over the quantities issued from bargaining.

Vis-a-vis the operational research literature, the work stands at the dual or multiple sourcing stream, which tries to compute the optimal procurement distribution, provided the set of supply sources. It also falls within the supply-contracting literature, where suppliers and buyers form contractual relationships to create and share profits in the supply chain. See Cachon and Lariviere (2005) and Dong and Liu (2007) for an overview.

The remainder of the paper is as follows. We present the Nash bargaining and the renegotiation frameworks, including the equilibrium properties, in Section 2. Section 3 is devoted to illustrating simulation examples. Section 4 concludes.

2. Model

Let there be a roundwood log supply contract in form of a pluriannual contract $<p_c,q_c>$, with q_c the quantity of logs and p_c their price per unit. The supplier and the manufacturer negotiate the supply contract according to the Nash bargaining game. Their respective negotiation costs are F_s and F_m. Parallel to the supply contracts, the supplier can also sell units of logs through the over-the-counter sales. The lumber demand D, the lumber sale price z, the over-the-counter log sale price p_l, and the timber auction clearing price p_t, are random variables with means and variances defined as $(\mu_D, \sigma_D^2), (\mu_z, \sigma_z^2), (\mu_{p_l}, \sigma_{p_l}^2)$, $(\mu_{p_t}, \sigma_{p_t}^2)$.

For computational purposes, we assume that one unit of lumber is produced from one unit of log, itself being obtained from one unit of timber. The supplier's total cost of producing l units of logs is $C(l) = w(l) + p_t l$, where $w(l)$ is the log economic storability. It is increasing and convex in l.

We assume that $\mu_{p_t} = c_0$, that is, the expected value of p_t is equal to its unit cost of carry c_0 which amounts to the timber auction clearing price plus the storage cost of the log. The assumption implies that the supplier has to both trade in the auction market and the supply timber contracts.

Consider that both the supplier and the manufacturer have some leeway in risk-taking and have mean-variance preferences over their profits. Let π be a firm's profit. The firm's utility is then

$$U_j(\pi) = E[\pi] - \lambda_j VAR[\pi]. \tag{1}$$

where $j \in \{s,m\}$ represents either the supplier or the manufacturer, λ_j is the risk-taking leeway, and E and VAR denote the expectation and the variance operators over the distribution of random variables D, z, p_l and p_t.

Let π_j and π_j be firm j's profits with and without a supply contract $<p_c,q_c>$. Firm j's utility gain from the supply contract is defined as

$$U_j(p_c,q_c) = U_j(\pi_j) - U_j(\bar{\pi}_j). \tag{2}$$