Pulp Friction: The Value of Quantity Contracts in Decentralized Markets

Olivier Darmouni, Simon Essig Aberg, and Juha Tolvanen

Columbia Business School, University of Michigan, and University of Vienna
The Pulp and Paper Industry

Market structure:

- **Quantity contracts (> 80%)**: Quantity set often year in advance, prices negotiated monthly
  - Used also in other intermediate goods markets like coal, steel, plywood, gas...
- **Decentralized spot (< 20%)**
Why does the pulp and paper industry rely on long-run quantity contracts? How would welfare change under alternative market structures?

Coase (1937): Market structure minimizes transaction costs.

Price dispersion in the decentralized spot market (search and bargaining frictions) + inelastic production
Using invoice and production data from a large seller we quantify 2 reasons:

1. Contracts allow avoiding search frictions by locking in high surplus partners (estimate: 75% of the value)
2. Serve as quantity insurance (estimate: 25% of the value)

Trade-off:

Contractual relationships ⇒ lock in good partners & mitigate q risk
vs.
Spot trade ⇒ ex-post optimal allocation of quantity
Price Dispersion at the Spot

**Figure:** There Is Substantial Spot Price Dispersion

*Notes.* Mill gate price among spot buyers after removal of a market-month fixed effect, relative to mean of one. Market is defined as product-region.
Production is inelastic

**Table:** Total Sales and Production Inelastic to Market Price in the Short Run

<table>
<thead>
<tr>
<th></th>
<th>(1) Log Total Sales</th>
<th>(2) Log Production</th>
<th>(3) Log Inventory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log Market Price</td>
<td>-0.17</td>
<td>-0.01</td>
<td>-0.38</td>
</tr>
<tr>
<td></td>
<td>(0.11)</td>
<td>(0.16)</td>
<td>(0.15)</td>
</tr>
<tr>
<td>Observations</td>
<td>72</td>
<td>72</td>
<td>72</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.19</td>
<td>0.07</td>
<td>0.28</td>
</tr>
<tr>
<td>Year FE</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>

*Notes.* Robust standard errors in parentheses. Observations are at the monthly level. Market price is the average price among the seller’s trading partners.
Contract Buyers Are on Average Better

**Figure:** Average Contract Price > Average Spot Price

**Notes.** The median and mean values equal 1.07. Each observation is trade within a region, fiber, and month. The price measure is mill gate price.

Logistics costs a big part of this
Contract Buyers Are More Reliable

**Figure:** Contract Buyers Are More Reliable Than Spot Buyers

**Notes.** The coefficient of variation equals the standard deviation of quantity over the mean quantity. Each observation is a buyer within a region, fiber, and year.
Stylized facts

Allocation Ex-Ante but not Ex-Post Optimal

**Figure:** Often: Lowest Contract Price < Lowest Spot Price

![Graph](image)

*Notes.* The median value equals 1.02 and the mean value equals 1.04. Each observation is trade within a region, fiber, and month.

Allocation not ex-post optimal $\Rightarrow$ Cost of inflexible contract quantities
Why quantity insurance?

Claim: Price dispersion (F1) $+$ inelastic supply (F2) $\Rightarrow$ Risk Aversion

Intuition: Consider selling fixed $Q$ to

1. A big customer buying random $q_c$ for fixed price $p$
2. Rest to spot market with price dispersion where you can choose the best offers
   - the $q_s$th unit sold there fetches price $p_s(q_s)$ with $p' < 0$
   - Revenue from spot then $\int_0^{q_s} p_s(q) dq$

Total revenue:

$$\Pi(q_c) = pq_c + \int_0^{Q-q_c} p_s(q) dq$$

$$\Rightarrow \Pi''(q_c) = p'(Q - q_c) < 0$$

Seller endogenously risk-averse with respect to contracted quantity!

When contract buyer buys more, it replaces better spot buyers than what can be found when it buys less.
We estimate value of quantity contracts with a structural model matching main market institutions. Outline:

1. Each year negotiate $q$ contracts with buyers
   - quantities set to max expected surplus
   - rebates set to split expected surplus via Nash-in-Nash

2. Each month:
   - Market shocks realize, $q$ contracts supplied, market conditions determine “market price” on which buyer gets the rebate
   - Remaining supply traded to spot where
     - Seller meets randomly an exogenous fraction of potential buyers
     - Selects the best of them and makes them take-it-or-leave-it offers

Information and contracting frictions preclude complete contracts at step 1

- Would require transfer of info about spot market outcomes...

Estimate with SMM in two steps
Counterfactual 1: Value of contracts

For each contract buyer consider moving them to spot. Calculate difference in surplus compared to current allocation.

**Figure:** Quantity Contracts Are Valuable

*Notes.* Median value 57 €/ton. Observation = contract buyer within a market and year. Median market price in Europe for hardwood pulp: 775€/ton.
Counterfactual 2: Value of insurance vs. buyer selection

Predict for each contract buyer what their quantity variance at spot would be. Then calculate value of contracts with this new variance.

Figure: Quantity Contracts Are 25% Less Valuable Without Quantity Insurance

Notes. The median value 43 €/ton. Observation = contract buyer within a market and year.
Counterfactual 3: Role of trading frictions at spot

Change the exogenous fraction of buyers ($\gamma$) the seller meets at spot. Reallocate buyers between spot and contract.

**Figure:** Profits Are Higher When Trading Frictions Diminish

With lower frictions more traded at spot and profits are higher.
The End

Thank you!