Vertical Relationships in Empirical IO

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Introduction

- Competition policy, regulation, public policy ... need measurement of firms' product margins, firms' marginal costs of production for:
  - market power analysis
  - counterfactual policy analysis
- Structural models estimation allows to understand firms behavior and perform counterfactual simulations
- Useful for analysis of merger, public policy, regulation of firms behavior through their price setting, contracting, advertising, and other strategic tools

Introduction

- Identification and measurement of firms' product margins is now well known for horizontal competition models
    - Usually starts with market level data allowing to estimate a demand model
    - Then uses a supply side horizontal competition model to provide necessary conditions on price equilibrium
    - Use price equilibrium condition to identify marginal costs
- Recent developments to identify and estimate margins when *vertical contracting* affects price equilibrium

Structural Estimation in Empirical IO

- Demand models
  - Lot of research since twenty five years on getting robust methods of identification of flexible demand models with many differentiated goods and unrestricted substitution patterns. Discrete choice models for differentiated products demand (Berry, 1994, BLP, 1995)
  - Better data, better models and methods, using aggregate level data or data at the decision-maker level
- Supply models
  - Given demand, supply specification allows to "reverse engineer" margins - if the model is identified
  - Simple Bertrand-Nash price competition model is generally identified and allows to recover price cost margins and marginal costs
  - Recent developments to account for vertical relationships, double marginalization, non linear contracts, bargaining, regulation ..

Plan

- Brief remarks on standard demand estimation
- Methods to identify margins
  - Horizontal price competition
  - Taking into account vertical relationships
    - Linear pricing
    - Two Part Tariffs contracts
    - Bargaining
  - Taking into account regulatory constraints

Demand

- Research on how to obtain a flexible demand function between quantities $\mathbf{q}$, prices $\mathbf{p}$, observed and unobserved shifters $(\mathbf{z}, \varepsilon)$:

$$\mathbf{q} = D(\mathbf{p}, \mathbf{z}, \varepsilon)$$

- Dimensionality reduction with demand in *characteristics space* instead of *product space*
- Classical demand models: Linear Expenditure model (Stone, 1954), Rotterdam model (Theil 1965, Barten 1966), Translog model (Christensen Jorgenson Lau 1975), Almost Ideal Demand System (Deaton and Muellbauer 1980), ...
- Random coefficient logit (Berry 1994, BLP 1995) has become the workhorse random utility model underlying consumer decisions

Random Coefficients Logit Model

- Identification and estimation on market or consumer level data
- Any random utility model can be approximated by a mixed logit model, provided the mixing distribution is adequate (McFadden and Train 2000)
- Random coefficients allow relax the strong restrictions on substitution patterns imposed by the Logit model
- Model is identified on market level data with instrumental variables for prices that must be independent of demand shocks
  - "BLP" instruments: characteristics of competing goods
  - Hausman instruments: prices in other markets (indirect cost measures)
  - Cost shifters
- No need to know or specify the supply side (Nevo 2001)

Extension of Discrete Choice Demand Models

- Multiple Discreteness: Hendel (1999)
- Discrete/continuous models (Dubin-McFadden 1984, Hanemann 1984, Smith 2004, Dubois Jodar, 2011, Dubois Griffith Nevo 2014)
- Dynamics, stockpiling (Hendel Nevo 2006, Dubois Magnac 2017)
- Uninformed consumer: search models (De los Santos Hortaçsu Wildenbeest 2012)

Demand Models

- Assume now demand shape is identified/known independently of the supply
- In some cases, demand cannot be fully identified without a supply side equilibrium model
- For example, the use supply side equilibrium conditions within the demand estimation method to infer :
  - unobservable stockpiling (Dubois Magnac, 2015) (consumer unobserved stockpiling depends on sales promotion probability which depends on supply side strategy)
  - unobserved choice set (Dubois Saethre, 2020) (patients choice of drugs depends on pharmacy optimal behavior)

Identifying Margins in Horizontal Price Competition

- Method is driven by typical data availability: data on sale quantities and retail prices usually good but marginal costs not available
- Example of oligopoly with J differentiated products, from F firms
- The static profit of firm f selling goods G_f is

$$\Pi_f = \sum_{j \in G_f} \underbrace{M}_{\text{market size}} \underbrace{(p_j - c_j)}_{\text{margin}} \underbrace{s_j(\mathbf{p}, \mathbf{z})}_{\text{market share of } j} - \underbrace{C_f(\mathbf{z})}_{\text{fixed cost}}$$

  for any vector of state variables $\mathbf{z}$ (advertising, regulation, ..).
- Normalize M to 1

Identifying Margins in Horizontal Price Competition

- Assuming Bertrand-Nash equilibrium across F firms, then first order conditions for all j are

$$s_j(\mathbf{p}, \mathbf{z}) + \sum_{k \in G_f} (p_k - c_k) \frac{\partial s_k(\mathbf{p}, \mathbf{z})}{\partial p_j} = 0$$

- Valid even in a dynamic setting for any MPE where price is one strategic variable, provided current price $\mathbf{p}_t$ does not affect future states $\mathbf{z}_{t+\tau}$ (Dubois, Griffith, O'Connell, 2018)
- If all relevant state variables $\mathbf{z}$ are observed, obtain J linear equations with J unknowns $(p_j - c_j)$, and margins are identified using

$$\mathbf{p} - \mathbf{c} = \Omega^{-1}\mathbf{s}(\mathbf{p}, \mathbf{z})$$

where $\Omega_{jk} = \begin{cases} -\partial s_k / \partial p_j & \text{if } \{k, j\} \subset G_f \\ 0 & \text{otherwise} \end{cases}$

Example

- Firm A owns goods 1 and 2 and firm B owns good 3

$$\frac{\partial s}{\partial p} = \begin{bmatrix} \frac{\partial s_1}{\partial p_1} = -2.4 & \frac{\partial s_2}{\partial p_1} = 0.2 & \frac{\partial s_3}{\partial p_1} = 0.1 \\ \frac{\partial s_1}{\partial p_2} = 0.3 & \frac{\partial s_2}{\partial p_2} = -3.1 & \frac{\partial s_3}{\partial p_2} = 0.4 \\ \frac{\partial s_1}{\partial p_3} = 0.6 & \frac{\partial s_2}{\partial p_3} = 0.7 & \frac{\partial s_3}{\partial p_3} = -1.8 \end{bmatrix} \quad s = \begin{bmatrix} 0.40 \\ 0.12 \\ 0.24 \end{bmatrix}$$

then

$$\begin{aligned} \begin{bmatrix} p_1 - mc_1 \\ p_2 - mc_2 \end{bmatrix} &= -\begin{bmatrix} -2.4 & 0.2 \\ 0.3 & -3.1 \end{bmatrix}^{-1} \begin{bmatrix} 0.40 \\ 0.12 \end{bmatrix} = \begin{bmatrix} 0.17 \\ 0.05 \end{bmatrix} \\ p_3 - mc_3 &= 0.24/1.8 = 0.13 \end{aligned}$$

Identifying Margins in Horizontal Price Competition

- Very powerful method:
  - identifies margins with data on market structure, demand shape and equilibrium prices and quantities
- Very useful:
  - Given current horizontal price competition model, marginal costs are identified and allow to perform horizontal merger simulation (Nevo, 2000) or simulate other counterfactual price equilibrium
  - Estimating margins under different horizontal price competition (collusion, Bertrand competition) and adding an external assumption on marginal costs or margins allows test between models of conduct (Nevo, 2001)

Counterfactual Merger Simulation

- Once recovered marginal costs, simulate post-merger price equilibrium
- Marginal costs are

$$\mathbf{c} = \mathbf{p}^{pre} + {\Omega^{pre}}^{-1}\mathbf{s}(\mathbf{p}^{pre}, \boldsymbol{\omega})$$

with $\Omega_{jk}^{pre} = \frac{\partial s_k}{\partial p_j}$ if $\{k, j\} \subset G_f^{pre}$, 0 otherwise

- Assuming same state variables $\boldsymbol{\omega}$ ($\boldsymbol{\omega}^{pre} = \boldsymbol{\omega}^{post}$) and same marginal cost ($\mathbf{c}^{pre} = \mathbf{c}^{post} = \mathbf{c}$), post merger prices satisfy

$$\mathbf{p}^{post} = \mathbf{c} - {\Omega^{post}}^{-1}\mathbf{s}(\mathbf{p}^{post}, \boldsymbol{\omega})$$

where Ω^{post} is the post merger matrix with $\Omega_{jk}^{post} = \frac{\partial s_k}{\partial p_j}$ if $\{k, j\} \subset G_f^{post}$, 0 otherwise. Then

$$\mathbf{p}^{post} = \mathbf{p}^{pre} \underbrace{+{\Omega^{pre}}^{-1}\mathbf{s}(\mathbf{p}^{pre}, \boldsymbol{\omega})}_{-\text{ margin pre merger}} \underbrace{-{\Omega^{post}}^{-1}\mathbf{s}(\mathbf{p}^{post}, \boldsymbol{\omega})}_{+\text{ margin post merger}}$$

Counterfactual Merger Simulation

- Allowing cost synergies before simulating post-merger price equilibrium
- Marginal costs pre merger are

$$\mathbf{c}^{pre} = \mathbf{p}^{pre} + \Omega^{pre^{-1}} \mathbf{s}(\mathbf{p}^{pre}, \boldsymbol{\omega})$$

- Assume marginal costs post merger are

$$\begin{aligned} \mathbf{c}^{post} &= f(\mathbf{c}^{pre}) \\ &= \lambda \mathbf{c}^{pre} \text{ for example} \end{aligned}$$

- Post merger prices satisfy

$$\mathbf{p}^{post} = \lambda \mathbf{c}^{pre} - \Omega^{post^{-1}} \mathbf{s}(\mathbf{p}^{post}, \boldsymbol{\omega})$$

where Ω^{post} is the post merger matrix with $\Omega^{post}_{jk} = \frac{\partial s_k}{\partial p_j}$ if $\{k, j\} \subset G^{post}_f$, 0 otherwise.

Example

- As

$$\mathbf{p}^{post} = \mathbf{p}^{pre} \underbrace{+{\Omega^{pre}}^{-1}\mathbf{s}(\mathbf{p}^{pre},\omega)}_{-\text{ margin pre merger}} \underbrace{-{\Omega^{post}}^{-1}\mathbf{s}(\mathbf{p}^{post},\omega)}_{+\text{ margin post merger}}$$

- When firms A and B merge, need to solve $(p_1^{post}, p_2^{post}, p_3^{post})$ as solution of

$$\begin{bmatrix} p_1^{post} - mc_1 \\ p_2^{post} - mc_2 \\ p_3^{post} - mc_3 \end{bmatrix} = \begin{bmatrix} 0.17 \\ 0.05 \\ 0.13 \end{bmatrix} - \begin{bmatrix} -2.4 & 0.2 & 0.1 \\ 0.3 & -3.1 & 0.4 \\ .6 & 0.7 & -1.8 \end{bmatrix}^{-1} \begin{bmatrix} s_1(p_1^{post}, p_2^{post}, p_3^{post}) \\ s_2(p_1^{post}, p_2^{post}, p_3^{post}) \\ s_3(p_1^{post}, p_2^{post}, p_3^{post}) \end{bmatrix}$$

Example: Nevo, 2000

- Demand estimation and use of a model of postmerger conduct to simulate competitive effects of a merger.
    - Estimate a brand-level demand system for ready-to-eat cereal with supermarket scanner data
    - Recover marginal costs
    - Simulate postmerger price equilibria
    - Compute welfare effects

Example: Nevo, 2000

TABLE 7 **Change in Variable Profits and Consumer Surplus as a Result of Mergers (millions of dollars per year)**

	Post and Nabisco		General Mills and Nabisco	
Consumer surplus	−13.98		−26.79	
Profits/revenues (total)	6.20	−4.77	10.66	−12.33
Kellogg	2.56	3.77	5.54	7.57
General Mills	2.34	3.65	2.63	−7.50
Post	.60	−5.17	1.54	2.94
Quaker Oats	.54	.84	1.43	2.07
Ralston	.14	.25	.30	.52
Nabisco	.01	−8.11	−.77	−17.93
Total Welfare	−7.78		−16.13	

Nevo (2000)

Cost reduction (so total welfare is unchanged)		1.5%		10.8%
Profits/revenues (total)	8.29	−1.81	16.89	−3.36
Kellogg	1.39	1.90	3.77	4.93
General Mills	1.35	1.92	.47	−13.46
Post	3.73	−.57	.65	1.18
Quaker Oats	.31	.43	1.12	1.58
Ralston	.09	.15	.20	.36
Nabisco	1.42	−5.65	10.68	2.07

The top half of the table is based on the results of Table 5. The bottom half displays the cost reductions required to keep total welfare unchanged, i.e., change in consumer surplus minus change in variable profits equals zero. The first three columns assume a fixed proportional reduction only to brands of acquired firm, while the last two columns assume cost reductions to brands of both firms.

Testing across models of horizontal price competition

- Under Bertrand-Nash competition

$$\mathbf{c} = \mathbf{p} - \Omega^{-1}\mathbf{s}(\mathbf{p}, \mathbf{z}) \longrightarrow c_{jt}^{0}$$

- Under collusion

$$\mathbf{c} = \mathbf{p} - \Omega_{\text{collusion}}^{-1}\mathbf{s}(\mathbf{p}, \mathbf{z}) \longrightarrow c_{jt}^{1}$$

- Can compare c_{jt}^{0} and c_{jt}^{1} to potentially observed accounting margins to reject one model or another
- Introduce a model for marginal costs

$$\begin{cases} c_{jt}^{0} = x_{jt}\beta^{0} + \varepsilon_{jt}^{0} \\ c_{jt}^{1} = x_{jt}\beta^{1} + \varepsilon_{jt}^{1} \end{cases}$$

and test which model has the better fit.

Issues with Horizontal Price Competition Model

- Ignores the possible intermediary between the producer and consumer: retailer, platform, ..
- Consumer prices may not be chosen by manufacturer/producer
- Can cause many problems: for example, likely bias towards finding collusion when there is none because retailer takes into account effects across products, estimated margins corresponding to retail margins only if linear pricing without vertical restraints
- Extension to vertical contracts necessary: double marginalization, non linear pricing, vertical restraints, multiple equilibria

Vertical Contracts between Manufacturers and Retailers

Some Literature

- Sudhir (2001): strategic interactions between manufacturers and a single retailer and focuses on linear pricing leading to double marginalization
- Asker (2005): role of foreclosure in strategic choices of vertical contracts on beer market
- Ho (2006): studies welfare effects of vertical contracting between hospitals and health maintenance organizations.
- Mortimer (2008), Ho, Ho and Mortimer (2012): revenue-sharing contracts in video rental industry
- Meza and Sudhir (2009): study how private labels affect bargaining power of retailers
- Villas Boas (2007): introduces non linear pricing
- Bonnet and Dubois (2010): explicitly models two part tariffs contracts

Vertical Linear Pricing: Double Marginalization

- Simple extension with linear pricing vertical contracts
- Retailer profit given wholesale prices $\mathbf{w}$

$$\Pi^r = \sum_{j \in S_r} \Big(\underbrace{p_j}_{\text{retail price}} - \underbrace{w_j}_{\text{wholesale price}} - \underbrace{c_j}_{\text{marginal cost of distribution}} \Big) s_j(\mathbf{p})$$

- Bertrand-Nash equilibrium in retail prices among retailers

$$s_j + \sum_{k \in S_r} (p_k - w_k - c_k) \frac{\partial s_k}{\partial p_j} = 0$$

identifies retail margins as solution of

$$\mathbf{p} - \mathbf{w} - \mathbf{c} = \Omega^{-1} \mathbf{s}(\mathbf{p}) \qquad \rightarrow \qquad (\mathbf{p} - \mathbf{w} - \mathbf{c})^*$$

where $\Omega_{jk} = \frac{\partial s_k}{\partial p_j}$

Vertical Linear Pricing: Double Marginalization

- Profit of manufacturer f is

$$\Pi^f = \sum_{j \in G_f} \Big(\underbrace{w_j}_{\text{wholesale price}} - \underbrace{\mu_j}_{\text{marginal cost of production}} \Big) s_j(\mathbf{p})$$

- Bertrand-Nash equilibrium in wholesale prices among manufacturers

$$s_j + \sum_{k \in G_f} \sum_{l=1,..,J} (w_k - \mu_k) \frac{\partial s_k}{\partial p_l} \frac{\partial p_l}{\partial w_j} = 0 \rightarrow \qquad (\mathbf{w} - \boldsymbol{\mu})^*$$

Derivatives $\frac{\partial p_l}{\partial w_j}$ by total differentiation of retailer's first order conditions

$\rightarrow$

$$\frac{\partial p_l}{\partial w_j} \left((p_k - w_k - c_k)_{k=1,..,J} \right)$$

Vertical Linear Pricing: Double Marginalization

- After identifying retail margins, we obtain retail price derivatives and thus a linear system of equations in wholesale margins
- Retail margins $(p_j - w_j - c_j)$ and wholesale margins $(w_j - \mu_j)$ are identified, thus total marginal cost $(\mu_j + c_j)$ is identified
- Shows the double marginalization problem
- Need observation of wholesale prices or additional restrictions if want to separately identify costs

Vertical Contracts with Non Linear Pricing

- But parties may have an incentive to use non linear pricing contracts, vertical restraints
- Theoretical arguments (Bernheim Whinston 1985, Rey Tirole 1986, O'Brien Shaffer 1997, Rey Vergé 2004)
- Empirical evidence (Villas-Boas, 2007, Bonnet Dubois, 2010)
- Price equilibrium conditions change relationship between margins, demand shape and market structure

Vertical Contracts with Non Linear Pricing

- Two-part Tariffs (Rey Vergé, 2004, 2010, Bonnet Dubois, 2010)
- Simultaneous take-it or leave-it offers from manufacturers to retailers
- Manufacturers set w_k and franchise fee F_k to maximize

$$\Pi^f = \sum_{k \in G_f} [(w_k - \mu_k) s_k(\mathbf{p}) + F_k]$$

subject to participation constraints $\Pi^r \geq \overline{\Pi}^r$, where

$$\Pi^r = \sum_{j \in S_r} [(p_j - w_j - c_j) s_j(\mathbf{p}) - F_j]$$

- As participation constraints must be binding:

$$\Pi^f = \sum_{k \in G_f} \underbrace{(p_k - \mu_k - c_k)}_{\text{total margin}} s_k(\mathbf{p}) + \sum_{k \notin G_f} \underbrace{(p_k - w_k - c_k)}_{\text{retail margin}} s_k(\mathbf{p}) - \sum_{j \notin G_f} F_j$$

Vertical Contracts with Non Linear Pricing

- Binding participation constraints ($\overline{\Pi}^r = 0$):

$$\sum_{j\in S_r} F_j = \sum_{j\in S_r} [(p_j - w_j - c_j)s_j(\mathbf{p})]$$

$$\begin{aligned}
\Pi^f &= \sum_{k\in G_f} [(w_k - \mu_k)s_k(\mathbf{p})] + \sum_{k\in G_f} F_k \\
&= \sum_{k\in G_f} [(w_k - \mu_k)s_k(\mathbf{p})] + \sum_r \left(\sum_{k\in S_r} F_k\right) - \sum_{k\notin G_f} F_k \\
&= \sum_{k\in G_f} (w_k - \mu_k)s_k(\mathbf{p}) + \sum_r [\sum_{j\in S_r} (p_j - w_j - c_j)s_j(\mathbf{p})] - \sum_{k\notin G_f} F_k \\
&= \sum_{k\in G_f} [(w_k - \mu_k)s_k(\mathbf{p})] + \sum_k (p_k - w_k - c_k)s_k(\mathbf{p}) - \sum_{k\notin G_f} F_k \\
&= \sum_{k\in G_f} (p_k - \mu_k - c_k)s_k(\mathbf{p}) + \sum_{k\notin G_f} (p_k - w_k - c_k)s_k(\mathbf{p}) - \sum_{j\notin G_f} F_j
\end{aligned}$$

Vertical Contracts with Non Linear Pricing

- Resale Price Maintenance (RPM) equilibrium :

$$\max_{\{p_k, w_k, F_k\} \in G_f} \Pi^f = \max_{\{p_k\} \in G_f} \Pi^f$$

- Pricing decisions implemented by manufacturers
- RPM equilibrium $\mathbf{p}^*(\mathbf{w}^*)$ satisfies for all firms f

$$\max_{\{p_k\} \in G_f} \sum_{k \in G_f} (p_k - \mu_k - c_k) s_k(\mathbf{p}) + \sum_{k \notin G_f} (p_k^* - w_k^* - c_k) s_k(\mathbf{p})$$

- Thus, first order conditions of RPM equilibrium

$$\sum_{k \in G_f} (p_k - \mu_k - c_k) \frac{\partial s_k(\mathbf{p})}{\partial p_j} + s_j(\mathbf{p}) + \sum_{k \notin G_f} (p_k - w_k - c_k) \frac{\partial s_k(\mathbf{p})}{\partial p_j} = 0$$

- Multiple equilibria depending on wholesale prices $\mathbf{w}$
- Contrary to linear pricing: **no identification of margins**

Vertical Contracts with Non Linear Pricing

- Identifying assumption (choosing a possible equilibrium):
    - $w_k^* = \mu_k$: retailers as residual claimants and manufacturers capture full monopoly rents through fixed fees. FOC are

$$\sum_{k=1}^{J}(p_k - \mu_k - c_k)\frac{\partial s_k(\mathbf{p})}{\partial p_j} + s_j(\mathbf{p}) = 0$$

    - $p_k^*(\mathbf{w}^*) - w_k^* - c_k = 0$:

$$\sum_{k\in G_f}(p_k - \mu_k - c_k)\frac{\partial s_k(\mathbf{p})}{\partial p_j} + s_j(\mathbf{p}) = 0$$

- Total margins are then identified but not wholesale and retail margins separately nor the sharing of profit in the vertical chain

Vertical Contracts with Non Linear Pricing

- *Without RPM*, manufacturer maximizes

$$\max_{\{w_k\}\in G_f} \sum_{k\in G_f} (p_k - \mu_k - c_k) s_k(\mathbf{p}) + \sum_{k\notin G_f} (p_k - w_k - c_k) s_k(\mathbf{p})$$

- The first order conditions are

$$\begin{aligned} 0 &= \sum_k \frac{\partial p_k}{\partial w_i} s_k(\mathbf{p}) + \sum_{k\in G_f} \left[(p_k - \mu_k - c_k) \sum_j \frac{\partial s_k}{\partial p_j} \frac{\partial p_j}{\partial w_i} \right] \\ &+ \sum_{k\notin G_f} \left[(p_k - w_k - c_k) \sum_j \frac{\partial s_k}{\partial p_j} \frac{\partial p_j}{\partial w_i} \right] \end{aligned}$$

Then, using retailers reaction function when setting optimal retail margins, retail and wholesale margins are identified (but again not the profits because fixed fees are unidentified). As $(p_k - \mu_k - c_k) = (p_k - w_k - c_k) + (w_k - \mu_k)$, the model is identified

Inference on Supply Side Models

- As each model is identified, **add restrictions**: either on costs, margins, or cross market variations of equilibrium
- Total marginal cost for model h is $C_{jt}^h = \mu_{jt}^h + c_{jt}^h$,

$$C_{jt}^h = p_{jt} - \underbrace{\left(w_{jt} - \mu_{jt}\right)^h}_{\text{model } h \text{ wholesale margin}} - \underbrace{\left(p_{jt} - w_{jt} - c_{jt}\right)^h}_{\text{model } h \text{ retail margin}}$$

- Example of test between models using cost restrictions:
  - across products (identification improves with more products and more retailing channels)

$$\mu_{jt}^h = \mu_{j't}^h \quad \text{if } b(j) = b(j') \quad \text{and} \quad c_{jt}^h = c_{j't}^h \quad \text{if } r(j) = r(,j')$$

  - across markets t (identification improves with more markets)

$$C_{jt}^h = W_{jt}'\alpha^h + \eta_{jt}^h \text{ with } E(\eta_{jt}^h | W_{jt})$$

- Non-nested tests (Vuong, 1989, and Rivers and Vuong, 2002) are then applied to infer which model h is statistically the best.

Inference on Supply Side Models

- Idea: infer which cost equation has best statistical fit given the observed cost shifters W_{jt}
- Test each model against each other, for models h and h'

$$p_{jt} = \Gamma^h_{jt} + \gamma^h_{jt} + W'_{jt}\alpha^h + \eta^h_{jt}$$

and

$$p_{jt} = \Gamma^{h'}_{jt} + \gamma^{h'}_{jt} + W'_{jt}\alpha^{h'} + \eta^{h'}_{jt}$$

Using NLLS

$$\begin{aligned}\min_{\alpha^h} Q^h_N(\alpha^h) &= \min_{\alpha^h} \frac{1}{n} \sum\nolimits_{j,t} (\eta^h_{jt})^2 \\ &= \min_{\alpha^h} \frac{1}{n} \sum\nolimits_{j,t} \left[p_{jt} - \Gamma^h_{jt} - \gamma^h_{jt} - W'_{jt}\alpha^h \right]^2\end{aligned}$$

Inference on Supply Side Models

- Null hypothesis: non-nested models *asymptotically equivalent* when

$$H_0 \;:\; \lim_{n\to\infty} \left\{ \bar{Q}_n^h(\overline{\alpha}^h) - \bar{Q}_n^{h'}(\overline{\alpha}^{h'}) \right\} = 0$$

where $\bar{Q}_n^h(\overline{\alpha}^h)$ (resp. $\bar{Q}_n^{h'}(\overline{\alpha}^{h'})$) are expectation of a lack-of-fit criterion $Q_n^h(\alpha^h)$

- Alternative hypothesis: h is *asymptotically better* than h' when

$$H_1 \;:\; \lim_{n\to\infty} \left\{ \bar{Q}_n^h(\overline{\alpha}^h) - \bar{Q}_n^{h'}(\overline{\alpha}^{h'}) \right\} < 0.$$

h' is *asymptotically better* than h when

$$H_2 \;:\; \lim_{n\to\infty} \left\{ \bar{Q}_n^h(\overline{\alpha}^h) - \bar{Q}_n^{h'}(\overline{\alpha}^{h'}) \right\} > 0.$$

Inference on Supply Side Models

- Test statistic $T_n = \frac{\sqrt{n}}{\hat{\sigma}_n^{hh'}} \left\{ Q_n^h(\widehat{\alpha}_h) - Q_n^{h'}(\widehat{\alpha}_{h'}) \right\}$ captures statistical variation of sample values of the lack-of-fit criterion
- $\hat{\sigma}_n^{hh'}$ denotes the estimated value of the variance of the difference in lack-of-fit.
- Rivers and Vuong showed that T_n is standard normal.

Bonnet and Dubois (2010)

Price-Cost Margins (% of Retail Price p)		Mineral Water Mean	Mineral Water Standard Deviation	Spring Water Mean	Spring Water Standard Deviation
Double Marginalization					
Model 1	Retailers	13.48	1.44	19.80	3.60
	Manufacturers	9.77	0.64	19.02	1.09
	Total	22.94	1.50	42.31	2.11
Model 2	Retailers	13.48	1.43	19.80	3.60
	Manufacturers	12.76	0.75	21.35	0.97
	Total	25.94	1.69	44.63	2.03
Model 3	Retailers	9.45	1.48	16.49	4.06
	Manufacturers	13.42	2.96	22.75	3.79
	Total	22.54	3.04	43.19	3.96
Model 4	Retailers	9.45	1.48	16.49	4.06
	Manufacturers	9.90	0.77	20.62	1.13
	Total	19.02	1.65	41.05	2.19
Model 5	Retailers	9.45	1.48	16.49	4.06
	Manufacturers	10.53	4.12	20.20	1.95
	Total	19.66	4.22	40.64	2.56
Two-part tariffs with RPM					
Model 6	Nash and $w = \mu$	12.90	1.03	17.87	5.29
Model 7	Nash and $p = w + c$	10.85	1.06	16.70	4.61
Two-part tariffs without RPM					
Model 8	Retailers	9.45	1.48	16.49	4.06
	Manufacturers	2.94	1.13	1.93	0.43
	Total	12.07	1.36	22.45	1.04

Bonnet and Dubois (2010)

Test Statistic $T_n = \frac{\sqrt{n}}{\hat{\sigma}_n}\left(Q_n^2(\hat{\Theta}_n^2) - Q_n^1(\hat{\Theta}_n^1)\right) \to N(0,1)$

$H_1 \diagdown H_2$	2	3	4	5	6	7	8
1	2.99	6.63	2.11	2.64	−6.51	−6.94	−0.84
	(5.33)	(6.19)	(7.54)	(4.23)	(4.31)	(4.24)	(6.68)
2		−2.35	−3.12	−0.18	−5.59	−5.84	−3.68
		(4.90)	(4.52)	(4.54)	(4.22)	(4.96)	(3.98)
3			−1.60	1.91	−7.22	−7.75	−1.41
			(7.29)	(4.67)	(4.74)	(5.05)	(6.84)
4				2.85	−8.00	−8.50	−1.04
				(3.30)	(4.17)	(3.90)	(5.97)
5					−4.95	−5.24	−3.58
					(3.15)	(3.60)	(4.56)
6						−5.09	2.86
						(4.49)	(3.92)
7							4.25
							(4.59)

Bonnet and Dubois (2010)

Policy (all Changes in %)	Change of Price p^*_{jt}		Change in Market Share s^*_{jt}
Nestlé/Perrier de-merger			
Average	−1.65 (0.13)		14.60 (1.61)
Average for Danone (BSN)	−1.59 (0.09)		14.52 (1.51)
Average for Nestlé	−1.93 (0.16)		19.09 (2.71)
Average for Perrier	−1.80 (0.18)		15.98 (2.30)
Average for Castel	−0.56 (0.19)		1.46 (1.02)
Average for private labels	−0.48 (0.21)		0.89 (1.88)
Average for outside good			−0.21 (0.02)
$\frac{CS_t(p_t)-CS_t(p_t^*)}{CS_t(p_t)}$ in %		1.35 (0.24)	
Double Marginalization (linear pricing)			
Average	6.73 (9.19)		−40.05 (56.79)
Average for Danone	6.82 (6.42)		−52.37 (6.33)
Average for Nestlé	7.23 (7.42)		−54.17 (9.24)
Average for Castel	15.45 (13.51)		−43.09 (141.71)
Average for private labels	−0.47 (6.41)		10.82 (2.81)
Average for outside good			1.05 (0.09)
$\frac{CS_t(p_t^*)-CS_t(p_t)}{CS_t(p_t)}$ in %		−13.18 (23.24)	
Two-part tariffs without RPM			
Average	−7.44 (5.44)		71.11 (50.12)
Average for Danone	−7.30 (0.66)		78.45 (9.33)
Average for Nestlé	−7.45 (0.85)		82.92 (12.15)
Average for Castel	−19.05 (1.52)		148.75 (21.81)
Average for private labels	0.30 (0.16)		−17.99 (2.80)
Average for outside good			−2.07 (0.42)
$\frac{CS_t(p_t)-CS_t(p_t^*)}{CS_t(p_t)}$ in %		0.81 (0.39)	

Identification in Vertical Contracts

- We can identify margins and marginal costs even in non linear vertical contracts (provided we maintain some cost restrictions), but *not* the sharing of profits because of unidentified and unobserved fixed transfers
- Solution: model the determination of reservation profits or bargaining ability of parties
- For example, allow downstream retailers to have some endogenous buyer power coming from the horizontal competition of upstream manufacturers (Bonnet Dubois 2015).
- Allows to recover price-cost margins at the upstream and downstream levels, as well as fixed fees of two part tariffs contracts and the sharing of profits

Two-Part Tariffs and Endogenous Retail Buyer Power

- Assume manufacturers make take-it-or-leave-it offers to retailers and characterize symmetric subgame perfect Nash equilibria.
- Rey and Vergé (2010) proved existence of equilibria:
  - Contracts: franchise fees, wholesale prices but also retail prices in case of RPM.
  - Offers are public and retailers simultaneously accept or reject.
  - Retailer can reject a contract while accepting others.
  - After decisions on contracts, retailers simultaneously set retail prices, demands and contracts are satisfied.
- Contracts negotiated at firm level and not by brand i.e. "bundling" offers to retailers. Likely to increase the market power of multiproduct manufacturers and reduce the buyer power of retailers.

Two-Part Tariffs and Endogenous Retail Buyer Power

- Manufacturers set two-part tariffs contracts to maximize their profit subject to incentive constraints

$$\Pi^r \geq \sum_{s \in S_r \setminus G_{fr}} [(\widetilde{p}_s^{fr} - w_s - c_s) s_s(\widetilde{p}^{fr}) - F_s]$$

  - $\widetilde{p}^{fr} = (\widetilde{p}_1^{fr}, .., \widetilde{p}_J^{fr})$ vector of retail prices absent products G_{fr}
  - $S_r \setminus G_{fr}$: set of products retailed by r but not manufactured by f
  - $s_s(\widetilde{p}^{fr})$: market share of s when products G_{fr} are absent
- Endogenous buyer power: retailers may refuse some contracts proposed by manufacturers while accepting other two-part tariffs contracts

Two-Part Tariffs and Endogenous Retail Buyer Power

- With binding incentive constraint:

$$\sum_{s\in G_{fr}} F_s = \sum_{s\in S_r} \left[(p_s - w_s - c_s) s_s(\mathbf{p}) - (\tilde{p}_s^{fr} - w_s - c_s) s_s(\tilde{\mathbf{p}}^{fr}) \right]$$

- Profit of manufacturer f becomes

$$\Pi^f = \sum_{s\in G_f} (w_s - \mu_s) s_s(\mathbf{p})$$
$$+ \sum_{s=1}^{J} \left[\underbrace{(p_s - w_s - c_s)}_{\text{retail margin if agree}} \underbrace{s_s(\mathbf{p})}_{\text{demand}} - \underbrace{(\tilde{p}_s^{fr(s)} - w_s - c_s)}_{\substack{\text{retail margin} \\ \text{if } r(s) \text{ refuses } f \text{ offer}}} \underbrace{s_s(\tilde{\mathbf{p}}^{fr(s)})}_{\substack{\text{counterfactual} \\ \text{demand}}} \right]$$

where $r(s)$ denotes the retailer of product s

Two-Part Tariffs and Endogenous Retail Buyer Power

- With RPM:
  - retail equilibrium price conditions identical as when exogenous reservation profit of retailer
  - but **fixed fees** in the contracts are endogenously determined and **identified** by retail equilibrium margins and counterfactual margins
- Without RPM:
  - all margins are also identified but different from exogenous case
  - **fixed fees** are also **identified**

With Resale Price Maintenance

- Manufacturers can choose retail prices while wholesale prices have no direct effect on profit.
- Then $\tilde{p}_i^{fr} = p_i$ if $i \notin G_{fr}$ and

$$\Pi^f = \sum_{s \in G_f} (w_s - \mu_s) s_s(\mathbf{p}) + \sum_{s=1}^{J} (p_s - w_s - c_s) \left[s_s(p) - s_s(\tilde{\mathbf{p}}^{fr(s)}) \right]$$

- With RPM, the retail buyer power does not change the retail equilibrium price conditions (but only the fixed fees in the contracts).

With Resale Price Maintenance

- Indeed, with RPM, Π^f is the sum of:
$\sum_{s\in G_f}(p_s-\mu_s-c_s)s_s(\mathbf{p})+\sum_{s\notin G_f}(p_s-w_s-c_s)s_s(\mathbf{p})$: profit without IC (fixed exogenous buyer power)
and
$-\sum_{s=1}^J(p_s-w_s-c_s)s_s(\tilde{\mathbf{p}}^{fr(s)})=-\sum_{s\notin G_f}(p_s-w_s-c_s)s_s(\tilde{\mathbf{p}}^{fr(s)})$:
"endogenous" rent left to retailer
- The "endogenous rent" left to the retailer is not affected by retail prices on own products because $\tilde{p}^{fr(s)}$ corresponds to prices when f products are not sold by r.

With Resale Price Maintenance

- First order conditions as if exogenous buyer power:

$$0 = s_j(\mathbf{p}) + \sum_{s \notin G_f} \left[(p_s - w_s - c_s) \frac{\partial s_s(\mathbf{p})}{\partial p_j} \right] + \sum_{s \in G_f} (p_s - \mu_s - c_s) \frac{\partial s_s(\mathbf{p})}{\partial p_j}$$

- Own wholesale prices don't matter but others do.
- A continuum of equilibria exist with RPM (Rey and Vergé, 2010).
- One equilibrium corresponds to each possible value of the vector of wholesale prices $\mathbf{w}$.

Without Resale Price Maintenance

- First order conditions of profit maximization of f with respect to w_j are:

$$0 = \sum_{i=1}^{J} \sum_{s \in G_f} (w_s - \mu_s) \frac{\partial s_s(\mathbf{p})}{\partial p_i} \frac{\partial p_i}{\partial w_j} + \sum_{s=1}^{J} \left[\frac{\partial p_s}{\partial w_j} s_s(\mathbf{p}) - \frac{\partial \tilde{p}_s^{fr(s)}}{\partial w_j} s_s(\tilde{\mathbf{p}}^{fr(s)}) \right]$$
$$+ \sum_{i,s=1}^{J} \left[(p_s - w_s - c_s) \frac{\partial s_s(\mathbf{p})}{\partial p_i} \frac{\partial p_i}{\partial w_j} - \left(\tilde{p}_s^{fr(s)} - w_s - c_s \right) \frac{\partial s_s(\tilde{\mathbf{p}}^{fr(s)})}{\partial p_i} \frac{\partial p_i}{\partial w_j} \right]$$

  where retailer's reaction is taken into account.
- Retail prices $\tilde{\mathbf{p}}^{fr}(\mathbf{w})$ are out of equilibrium prices: obtained from observed equilibrium retail prices, retail margins at equilibrium and out of equilibrium retail margins using:

$$\tilde{p}_s^{fr(s)} = \tilde{\gamma}_s^{fr(s)} - (p_s - w_s - c_s) + p_s$$

  where $\tilde{\gamma}_s^{fr(s)} = \tilde{p}_s^{fr(s)} - w_s - c_s$ is out of equilibrium retail margin.

Without Resale Price Maintenance

- Derivatives of retail prices with respect to wholesale prices can be deduced from differentiation of retailer's first order conditions.

$$s_j(\tilde{\mathbf{p}}^{fr}) + \sum_{s\in S_r\setminus G_{fr}} (\tilde{p}_s^{fr} - w_s - c_s)\frac{\partial s_s(\tilde{\mathbf{p}}^{fr})}{\partial \tilde{p}_j^{fr}} = 0$$

which gives for $r = 1,..,R$, $j \in S_r$ and $s = 1,..,J'$:

$$0 = \sum_{l\in\{1,..,J\}\setminus G_{fr}} \frac{\partial s_j(\tilde{\mathbf{p}}^{fr(j)})}{\partial \tilde{p}_l^{fr(j)}}\frac{\partial \tilde{p}_l^{fr(j)}}{\partial w_s} - 1_{\{s\in S_r\}}\frac{\partial s_s(\tilde{p}^{fr(j)})}{\partial \tilde{p}_j^{fr(j)}} + \sum_{l\in S_r}\frac{\partial s_l(\tilde{\mathbf{p}}^{fr(j)})}{\partial \tilde{p}_j^{fr(j)}}\frac{\partial \tilde{p}_l^{fr(j)}}{\partial w_s}$$
$$+ \sum_{l\in S_r\setminus G_{fr}}\left[(\tilde{p}_l^{fr} - w_l - c_l)\sum_{s\in\{1,..,J\}\setminus G_{fr}}\frac{\partial^2 s_l(\tilde{\mathbf{p}}^{fr(j)})}{\partial \tilde{p}_j^{fr(j)}\partial \tilde{p}_s^{fr(j)}}\frac{\partial \tilde{p}_s^{fr(j)}}{\partial w_s}\right]$$

- One can express manufacturer's price-cost margins vector as depending on the demand function and the structure of the industry by replacing the expression for retail price reaction to wholesale price.

Fixed Fees

- As the incentive constraints are binding, we have

$$\begin{aligned}
\sum_{s\in G_{fr}} F_s &= \sum_{s\in S_r}\left[(p_s-w_s-c_s)s_s(\mathbf{p})-(\tilde{p}_s^{fr}-w_s-c_s)s_s(\tilde{\mathbf{p}}^{fr})\right] \\
&= \sum_{s\in S_r}(p_s-w_s-c_s)s_s(\mathbf{p})-\sum_{s\in S_r\backslash G_{fr}}(p_s-w_s-c_s)s_s(\tilde{\mathbf{p}}^{fr}) \\
&= \sum_{s\in G_{fr}}(p_s-w_s-c_s)s_s(\mathbf{p}) \\
&\quad+\sum_{s\in S_r\backslash G_{fr}}(p_s-w_s-c_s)\left[s_s(\mathbf{p})-s_s(\tilde{\mathbf{p}}^{fr})\right]
\end{aligned}$$

- Without resale price maintenance, first order conditions determine retail margins $(p_s-w_s-c_s)$ at equilibrium. Out of equilibrium margins $(\tilde{p}_s^{fr}-w_s-c_s)$ in case r refuses offer of f known using demand shape and marginal costs
- Then, $\sum_{s\in G_{fr}} F_s$ can be identified for all pair (f,r): fixed fees exchanged between any manufacturer-retailer

Estimation Results

- Estimation in Bonnet Dubois (2015) on French markets for bottles of water
- Variants of linear pricing models not shown:
  - Different interaction between manufacturers and retailers.
  - Assuming collusion between manufacturers and/or retailers or assuming that retailers act as neutral pass-through agents of marginal cost of production (Sudhir, 2001).
  - All these models are strongly rejected.
- Model where no wholesale price discrimination imposed (restrictions incorporated in estimation of margins): wholesale price of j depends only on brand $b(j)$ and not on retailer $r(j)$.

Estimation Results

Price-Cost Margins (% of p_{jt})		Mineral Water		Spring Water	
		Mean	Std.	Mean	Std.
Linear Pricing (Double Marginalization)					
Model 1	Retailers	16.93	2.36	26.56	6.92
	Manufacturers	23.35	4.14	44.12	5.98
	Total	36.39	8.40	58.62	27.48

Estimation Results

Price-Cost Margins (% of p_{jt})		Mineral Water		Spring Water	
		Mean	Std.	Mean	Std.
Two part Tariffs with RPM					
Model 2	General wholesale prices (w_{jt}) with restriction on costs				
	Retailers	49.05	23.49	45.95	36.69
	Manufacturers	5.25	21.43	21.43	41.14
	Total	54.30	14.51	67.38	33.62
Model 3	No wholesale price discrim. ($w_{b(j)t}$) with restriction on costs				
	Retailers	61.46	17.18	29.72	8.77
	Manufacturers	0.00	0.00	44.32	45.47
	Total	61.46	17.18	74.04	39.53
Model 4	Zero wholesale margin ($w{=}\mu$)	66.32	19.08	78.18	41.04
Model 5	Zero retail margin ($p{=}w+c$)	25.53	5.07	43.39	14.40

Estimation Results

Price-Cost Margins		Mineral Water		Spring Water	
(% of retail price p_{jt})		Mean	Std.	Mean	Std.
Two-part Tariffs without RPM					
	Exogenous Retail Buyer Power				
Model 6	Retailers	16.93	2.36	26.56	6.92
	Manufacturers	18.75	3.88	25.76	3.99
	Total	32.56	6.58	49.44	18.21
	Endogenous Retail Buyer Power				
Model 7	Retailers	16.93	2.36	26.56	6.92
	Manufacturers	21.71	6.39	49.53	13.71
	Total	35.03	8.77	61.33	31.26

Non Nested Tests

- Cost equations test which model fits best the data (Vuong 1989, Rivers Vuong 2002)

$T_n \longrightarrow N(0,1)$: Non Nested Tests						
$\diagdown$	H_2					
H_1	2	3	4	5	6	7
1	1.10	0.71	0.28	7.48	4.25	**-3.16**
2		-3.79	-4.99	14.22	9.33	**-2.51**
3			-5.47	13.72	10.01	**-2.37**
4				13.14	9.85	**-2.21**
5					-11.38	**-5.60**
6						**-3.99**

- Tests statistics show best model is model 7.

Estimation Results

- Fixed fees identified in preferred model

$$\sum_{s \in G_{fr}} F_s = \sum_{s \in S_r} \left[(p_s - w_s - c_s) s_s(p) - (\widetilde{p}_s^{fr} - w_s - c_s) s_s(\widetilde{p}^{fr}) \right]$$

Retailer	Manufacturer 1	Manufacturer 2	Manufacturer 3
1	-1,672	294	-555
2	-18,910	-15,420	-17,650
3	1,087	1,378	1,215
4	2,509	2,621	2,534
5	3,271	607	1,216
6	1,063	1,114	1,091
7	972	1,016	1,000

Notes: Numbers are average fees per month in thousands of Euros.

Results

Profits decomposition

$$\begin{aligned}
\Pi^r &= \sum\nolimits_{s\in S_r}\left[(p_s - w_s - c_s)s_s(\mathbf{p})\right] - \sum\nolimits_{s\in S_r} F_s \\
&= \sum\nolimits_f \underbrace{\sum_{s\in G_{fr}} F_s\left[(p_s - w_s - c_s)s_s(\mathbf{p})\right]}_{\equiv\Pi^r_{fr}:\ \text{retail variable profits on } G_{fr} \text{ products}} - \underbrace{\sum\nolimits_f F_{fr}}_{\text{fees paid to manufacturers by } r}
\end{aligned}$$

$$\begin{aligned}
\Pi^f &= \sum\nolimits_{s\in G_f}\left[(w_s - \mu_s)s_s(\mathbf{p})\right] + \sum\nolimits_{s\in G_f} F_s \\
&= \sum\nolimits_r \underbrace{\sum_{s\in G_{fr}}\left[(w_s - \mu_s)s_s(\mathbf{p})\right]}_{\equiv\Pi^w_{fr}:\ \text{wholesale variable profits on } G_{fr} \text{ products}} + \underbrace{\sum\nolimits_r F_{fr}}_{\text{fees from all retailers to } f}
\end{aligned}$$

Estimation Results

Profits decomposition

Each cell reports $\binom{\Pi^w_{fr}}{\Pi^r_{fr}}$	Manufacturer f			Totals by Retailer r		
				Variable Profit	Total Fees	Total Profit
Retailer r	1	2	3	$\sum_f \Pi^r_{fr}$	$\sum_f F_{fr}$	Π^r
1	7,159	23,829	4,009			
	8,054	15,632	3,323	27,009	−1,933	28,942
2	14,326	38,775	6,389			
	12,837	23,548	4,997	41,382	−51,980	93,362
3	6,542	19,589	3,348			
	6,654	12,121	2,708	21,483	3,680	17,803
4	8,777	26,631	4,387			
	9,680	17,802	3,683	31,165	7,664	23,501
5	13,609	41,158	7,654			
	16,880	31,075	6,790	54,745	5,094	49,651
6	4,415	13,232	1,956			
	3,926	7,324	1,491	12,741	3,268	9,473
7	4,011	15,106	1,767			
	3,404	7,869	1,441	12,714	2,988	9,726
Totals by manufacturer f						
Variable Profit $\sum_r \Pi^w_{fr}$	58,839	178,320	29,510			
Total Fees $\sum_r F_{fr}$	−11,680	−8,390	−11,149			
Total Profit Π^f	47,159	169,930	18,361			

Bargaining in Vertical Contracts

- Literature has also recently used the concept of Nash Bargaining to rationalize vertical contracts.
  - Prices are negotiated through bilateral negotiations (Crawford Yurukoglu, 2012, Grennan, 2013, "Price discrimination and bargaining: Empirical evidence from medical devices", American Economic Review)
  - Bargaining ability and merging: A party in negotiations will earn more beneficial terms of trade by improving its bargaining position. A firm can increase its bargaining power by merging with a competitor (Gowrisankaran, Nevo, Town, 2015, "Mergers When Prices Are Negotiated: Evidence from the Hospital Industry" American Economic Review)
  - Bargaining on wholesale prices between retailers and suppliers (Dubois, Saethre, 2020)

Bargaining in Vertical Linear Pricing

- Sequential model where bargaining on wholesale prices and retail prices fixed in second stage
- Bertrand-Nash equilibrium in retail prices among retailers

$$s_j + \sum_{k \in S_r} (p_k - w_k - c_k) \frac{\partial s_k}{\partial p_j} = 0$$

identifies retail margins as solution of

$$\mathbf{p} - \mathbf{w} - \mathbf{c} = \Omega^{-1} \mathbf{s}(\mathbf{p}) \qquad \rightarrow \qquad (\mathbf{p} - \mathbf{w} - \mathbf{c})^*$$

where $\Omega_{jk} = \frac{\partial s_k}{\partial p_j}$ but cannot identify wholesale margin

- Add a Nash bargaining stage (Horn and Wolinsky, 1988) with $\beta_{fr} \in [0, 1]$

$$\max_{\{w_j\}_{j \in G_{fr}}} \left(\Pi^r - \Pi^{r \setminus f}\right)^{\beta_{fr}} \left(\Pi^f - \Pi^{f \setminus r}\right)^{1 - \beta_{fr}}$$

Bargaining in Vertical Linear Pricing

- Retailer profit given wholesale prices $\mathbf{w}$:

$$\Pi^r = \sum_{j \in S_r} \Big(\underbrace{p_j}_{\text{retail price}} - \underbrace{w_j}_{\text{wholesale price}} - \underbrace{c_j}_{\text{cost of distribution}} \Big) s_j(\mathbf{p})$$

$$\Pi^{r \backslash f} = \sum_{j \in S_r \backslash G_f} \Big(\underbrace{\widetilde{p}_j^{fr}(\mathbf{w})}_{\text{retail price}} - \underbrace{w_j}_{\text{wholesale price}} - \underbrace{c_j}_{\text{cost of distribution}} \Big) s_j(\widetilde{p}^{fr}(\mathbf{w}))$$

- Profit of manufacturer f :

$$\Pi^f = \sum_{j \in G_f} \Big(\underbrace{w_j}_{\text{wholesale price}} - \underbrace{\mu_j}_{\text{cost of production}} \Big) s_j(\mathbf{p})$$

$$\Pi^{f \backslash r} = \sum_{j \in G_f \backslash S_r} \Big(\underbrace{w_j}_{\text{wholesale price}} - \underbrace{\mu_j}_{\text{cost of production}} \Big) s_j(\widetilde{p}^{fr}(\mathbf{w}))$$

where $\widetilde{p}^{fr}(\mathbf{w})$ from retailers equilibrium FOC.

Bargaining in Vertical Linear Pricing

- Nash in Nash equilibrium first order conditions are:

$$\beta_{fr}\frac{\partial \ln\left(\Pi^{r}-\Pi^{r\backslash f}\right)}{\partial w_j}+(1-\beta_{fr})\frac{\partial \ln\left(\Pi^{f}-\Pi^{f\backslash r}\right)}{\partial w_j}=0$$

- If bargaining parameter β_{fr} is known, this first order condition allows to identify wholesale margin
- If bargaining parameter β_{fr} is unknown:
  - Need additional restrictions for identification
  - For example using cross markets variations and restrictions on marginal costs and bargaining parameters

Contracts as the Result of Bargaining

- Consider a Nash equilibrium in Nash Bargaining over two part tariffs contracts

$$\max_{(w_j,F_j),j\in G_{fr}} \left(\Pi^r - \Pi^{r\setminus f}\right)^{\beta}\left(\Pi^f - \Pi^{f\setminus r}\right)^{1-\beta}$$

where

$$\begin{aligned}\Pi^{r\setminus f} &= \textstyle\sum_{j\in S_r\setminus G_{fr}}[(p_j^{-fr} - w_j - c_j)s_j(\mathbf{p}^{-fr}) - F_j]\\ \Pi^{f\setminus r} &= \textstyle\sum_{j\in G_f\setminus G_{fr}}[(w_j - \mu_j)s_j(\mathbf{p}^{-fr}) + F_j]\end{aligned}$$

Contracts as the Result of Bargaining

- Taking first order conditions with respect to fixed fees:

$$\Pi^f - \Pi^{f\backslash r} = \frac{1-\beta}{\beta}\left(\Pi^r - \Pi^{r\backslash f}\right)$$

thus giving

$$\sum\nolimits_{j \in G_{fr}} F_j =$$

$$(1-\beta)\left(\sum_{j \in S_r}(p_j - w_j - c_j)s_j(\mathbf{p}) - \sum_{j \in S_r \backslash G_{fr}}(p_j^{-fr} - w_j - c_j)s_j(\mathbf{p}^{-fr})\right)$$

$$-\beta\left(\sum_{j \in G_f}(w_j - \mu_j)s_j(\mathbf{p}) - \sum_{j \in G_f \backslash G_{fr}}(w_j - \mu_j)s_j(\mathbf{p}^{-fr})\right)$$

- Fixed fees identified up to β. Bounds identified since $\beta \in [0,1]$

Contracts as the Result of Bargaining

- Replacing the fixed fees in profit functions, Nash bargaining amounts to maximize for $j \in G_{fr}$

$$\sum_{j \in S_r} [(p_j - w_j - c_j) s_j(\mathbf{p})] - \sum_{j \in S_r \setminus G_{fr}} [(p_j^{-fr} - w_j - c_j) s_j(\mathbf{p}^{-fr})]$$
$$+ \sum_{j \in G_f} [(w_j - \mu_j) s_j(\mathbf{p})] - \sum_{j \in G_f \setminus G_{fr}} [(w_j - \mu_j) s_j(\mathbf{p}^{-fr})]$$

which is equivalent to maximize

$$\underbrace{\sum_{j \in S_r} (p_j - w_j - c_j) s_j(\mathbf{p})}_{\text{variable retail margin of } r} + \underbrace{\sum_{j \in G_f} (w_j - \mu_j) s_j(\mathbf{p})}_{\text{variable wholesale margin of } f}$$

Contracts as the Result of Bargaining

- How are two-part tariffs with endogenous buyer power different from a bargaining outcome?
- With take it or leave it TPT contracts, maximize

$$\sum_{j\in G_f}(w_j-\mu_j)s_j(\mathbf{p})+\sum_{j=1}^{J}(p_j-w_j-c_j)s_j(\mathbf{p})-(\widetilde{p}_j^{fr(j)}-w_j-c_j)s_j(\widetilde{\mathbf{p}}^{fr(j)}$$

$$=$$

$$\sum\nolimits_{j\in S_r}[(p_j-w_j-c_j)s_j(\mathbf{p})]+\sum\nolimits_{j\in G_f}(w_j-\mu_j)s_j(\mathbf{p}) \quad \text{(TPT bargaining)}$$

$$-\underbrace{\sum\nolimits_{j\in S_r\setminus G_{fr}}[(\widetilde{p}_j^{fr(j)}-w_j-c_j)s_j(\widetilde{\mathbf{p}}^{fr(j)})]}_{\text{retailer } r \text{ margin on non } f \text{ products}}$$

$$+\underbrace{\sum\nolimits_{j\notin S_r}\left[(p_j-w_j-c_j)s_j(\mathbf{p})-(\widetilde{p}_j^{fr(j)}-w_j-c_j)s_j(\widetilde{\mathbf{p}}^{fr(j)})\right]}_{\text{change in retail margin obtained by other retailers when } r \text{ refuses } f \text{ offer}}$$

Contracts as the Result of Bargaining

- With take-it-or-leave-it offers of two part tariffs, manufacturers adjust contractual terms in order to extract the variable margin gain they obtain by accepting their contract offer compared to refusing
- Margins and marginal costs are identified using first order conditions
- Bargaining parameter does not affect equilibrium prices but affects fixed fees and sharing of profit that are not identified without assumption on β

Dubois and Lasio "Identifying Industry Margins with Price Constraints: Structural Estimation on Pharmaceuticals" (2018)

- Objective:
  - Develop a method to identify margins when prices are *possibly* not freely chosen by firms
  - Apply method in pharmaceutical sector to investigate whether regulation affects prices of drugs
  - Relate regulatory reforms in France to industry pricing equilibrium
- Methodology:
  - Structural estimation of price-cost margins on a regulated market with unobserved price constraints
  - Identification of supply model with unobserved constraints using cost restrictions across markets

Dubois and Lasio (2018)

- Application on Antiulcer Market for France, US and Germany (2003-2013)
- Findings:
    - Firms *sometimes* constrained in price setting
    - Regulatory constraints *sometimes* ineffective
    - Some spillover effects of regulatory constraints
    - Price constraints generated modest savings (2% of total expenses) and increased consumer surplus, relative to a free pricing scenario. Come from shifting consumption towards branded drugs at the expense of generics.
    - Simulate counterfactual policy defining price caps based on prices in other countries (external reference pricing): would increase generic penetration and generate additional savings and consumer surplus by reducing all prices, particularly those of generics.

Pharmaceutical Prices Regulation in France

- Complex regulation
  - Market Authorization: OTC versus Prescription Drug
  - Request for Sickness Insurance Coverage:
    - Medical benefit (SMR) and improvement in medical benefit (ASMR, I to V) determined by Transparency Commission (HAS)
    - Reimbursement rate depends on severity of illness and medical benefit (0%, 35%, 65%, 100%)
  - Price Setting (except for hospital drugs):
    - Economic Committee for Health Products (CEPS) negotiates with companies and imposes price caps

Profit Maximization Equilibrium

- Firms choose prices simultaneously after observing demand factors:
  - Profit Π_{ft} of multiproduct firm f in market t (year or country)

$$\Pi_{ft} = \sum_{j \in F_f} (p_{jt} - c_{jt})\, q_{jt}(\mathbf{p}_t, \mathbf{a}_t) - a_{jt}$$

    where $\mathbf{p}_t = (p_{1t}, ., p_{Jt})$ and advertising $\mathbf{a}_t$
  - First-order conditions of Bertrand-Nash equilibrium in prices, $\forall j \in F_f$

$$q_{jt} + \sum_{k \in F_f} (p_{kt} - c_{kt}) \frac{\partial q_{kt}(\mathbf{p}_t, \mathbf{a}_t)}{\partial p_{jt}} = 0$$

  - System of equations to solve for price-cost margins:

$$D_f (\mathbf{p}_t - \mathbf{c}_t) = -\left[D_f Q_{p_t} D_f\right]^{-1} D_f \mathbf{q}_t$$

    where D_f is firm f ownership $J \times J$ matrix.

Price Constrained Profit Maximization

- Price regulation imposes price-ceiling on drugs:
  - Explicit constraints: regulatory rules
  - Implicit constraints: negotiation between regulator and industry
- Ω_{jt} constrains the price p_{jt} in any possible way
  - Could impose that price must be lower than $\overline{p}_{jt}$, then $\Omega_{jt} = \left[0, \overline{p}_{jt}\right]$
  - Could be a maximum revenue constraint that constrains set Ω_{jt} for p_{jt} or other constraints
- Firm r constrained profit maximization becomes:

$$\max_{\{p_{jt}\}_{j \in F_f}} \Pi_{ft} = \sum_{j \in F_f} \left(p_{jt} - c_{jt}\right) q_{jt}\left(\mathbf{p}_t\right) \qquad s.t. \quad p_{jt} \in \Omega_{jt}$$

Price Constrained Profit Maximization

- Assuming pure-strategy Bertrand-Nash equilibrium in prices:

$$q_{jt} + \sum_{k \in F_f} (p_{kt} - c_{kt}) \frac{\partial q_{kt}(\mathbf{p}_t)}{\partial p_{jt}} = \lambda_{jt} \qquad \forall j \in F_f, \forall f$$

- Even in the simpler case where the constraint is $p_{jt} \leq \overline{p}_{jt}$, we know that

$$\lambda_{jt} > 0 \Rightarrow p_{jt} = \overline{p}_{jt} \text{ and } \lambda_{jt} = 0 \Rightarrow p_{jt} < \overline{p}_{jt}$$

  but $\overline{p}_{jt}$ also unknown.

Price Constrained Profit Maximization

- If instead of price caps regulation we have bargaining where government cares for welfare $W_t(\mathbf{p}_t)$
- Nash-in-Nash bargaining equilibrium in price would imply

$$\begin{aligned}\frac{\partial \Pi_{ft}(\mathbf{p}_t)}{\partial p_{jt}} &= q_{jt}(\mathbf{p}_t) + \sum_{k \in F_f} (p_{kt} - c_{kt}) \frac{\partial q_{kt}(\mathbf{p}_t)}{\partial p_{jt}} \\ &= \frac{1-\theta_{jt}}{\theta_{jt}} \frac{\partial \ln \Delta_f W_t(\mathbf{p}_t)}{\partial p_{jt}} \Pi_{ft}(\mathbf{p}_t)\end{aligned}$$

Price Constrained Profit Maximization

- There is always a $\theta_{jt} \in [0,1]$ such that $\frac{1-\theta_{jt}}{\theta_{jt}}\Pi_{ft}(p_t)\frac{\partial \ln \Delta_f W_t(\mathbf{p}_t)}{\partial p_{jt}} = \lambda_{jt}$ since $\lambda_{jt} \geq 0$
- Implying that constrained Bertrand-Nash equilibrium can be seen as the solution of a Nash-in-Nash bargaining model.
- Constraints on the bargaining parameters θ_{jt} imposes restrictions on the equilibrium prices.
- Bertrand-Nash equilibrium with price caps allows $\frac{\partial \Pi_{ft}(\mathbf{p}_t)}{\partial p_{jt}}$ to be zero when p_{jt} is lower than the price cap, while Nash bargaining model with $\theta_{jt} = \theta_{ft} \in]0,1[$ implies that it is always strictly positive.

Price Constrained Profit Maximization

- First order conditions of firm r

$$D_f \left(\mathbf{p}_t - \mathbf{c}_t \right) = - \left[D_f \, Q_p \left(\mathbf{p}_t \right) D_f \right]^{-1} D_f \left(\mathbf{q}_t - \boldsymbol{\lambda}_t \right)$$

  where $\boldsymbol{\lambda}_t$ are unknown (unknown binding constraints).
- Even with demand estimates, prices and market shares, cannot identify price-cost margins without further assumptions.
- Net effect of regulation on prices is ambiguous and depends on all own and cross price elasticities of demand.
- Price reduction of a drug can affect other drugs not explicitly constrained because of cross price elasticity of demand.

Price Constrained Profit Maximization

- Using subscript f for pre-multiplication by D_f (puts to zero all non firm f rows), first order conditions give

$$\mathbf{c}_t^f(\boldsymbol{\lambda}_t^f) = \mathbf{p}_t^f + Q_p^f(\mathbf{p}_t)^{-1}(\mathbf{q}_t^f - \boldsymbol{\lambda}_t^f)$$

- We have
$$\frac{\partial c_{it}^f(\boldsymbol{\lambda}_t^f)}{\partial \boldsymbol{\lambda}_{jt}^f} = -\left[Q_p^f(\mathbf{p}_t)^{-1}\right]_{i,j} \text{ for } i,j \in F_f$$

- We add some restrictions to identify the constraints

Identification with Additional Restrictions

- Can identify costs of drugs in unconstrained markets (by assumption)

$$\boldsymbol{\lambda}_t = 0 \text{ for any } t \in S$$

- Assume that for markets $t_0 \notin S$:

$$c_{jt} - c_{jt_0} = \left(\mathbf{z}_{jt} - \mathbf{z}_{jt_0}\right)' \delta + \omega_{jt} \quad \text{with} \quad E\left(\omega_{jt} | \mathbf{z}_{jt} - \mathbf{z}_{jt_0}\right) = 0$$

  means that cost differences between markets S and others satisfy the cost restriction above

- Then

$$\mathbf{c}_{t_0} = \mathbf{p}_{t_0} + Q_p^f(\mathbf{p}_{t_0})^{-1}(\mathbf{q}_{t_0} - \boldsymbol{\lambda}_{t_0})$$

  where $\boldsymbol{\lambda}_{t_0}$ identified from moment condition:

$$E\left(\boldsymbol{\omega}_t\left(\delta, \boldsymbol{\lambda}_{t_0}\right)\right) = 0$$

- Estimation:

$$\boldsymbol{\lambda}_t = \arg\min_{\boldsymbol{\lambda} \geq \mathbf{0}} \left\| \left[I - \mathbf{z}_t \left(\mathbf{z}_t'\mathbf{z}_t\right)^{-1} \mathbf{z}_t' \right] \left(\mathbf{c}_t\left(\boldsymbol{\lambda}, \mathbf{p}_t, \mathbf{q}_t\right)\right) \right\|$$

Data

- IMS Health: wholesale level transactions, 2003-2013 for several countries
  - Annual revenues (US $) & quantities (std units) per drug (molecule, brand, format)
  - Drug characteristics: brand name, manufacturer, ATC class, active ingredient, therapeutic presentations
- Information on indications, side effects, medical benefit (SMR), reimbursement rate
- Input prices: producer price index for pharmaceuticals in different countries (BLS, INSEE, Eurostat)
- Data aggregation at therapeutic form level
  - One observation per drug-year
  - Unbalanced panel with growing number of drugs

Demand Model

- Aggregate demand must be flexible enough because demand comes from:
  - Hospitals, even if mostly community market for antiulcer drugs
  - Outpatients and Prescribers
  - Regulator intervention
  - Pharmacy substitution
- Price sensitivity
  - Heterogenous out of pocket payment, average 10%
  - Pharmacies role in substitutions:
    - Pharmacy margins are decreasing in price
    - Pharmacies absolute margins are as large for generics than branded drugs
- Use flexible demand model for differentiated products to represent aggregate demand faced by pharmaceutical companies

Demand Model

- Random utility model: $j = 1, .., J$

$$u_{ijt} = \sum_k \alpha_i^k x_{jt}^k - \beta_i^0 p_{jt} 1_{\{p_{jt} \leq \bar{p}_{jt}^{tfr}\}} - \beta_i^1 p_{jt} 1_{\{p_{jt} > \bar{p}_{jt}^{tfr}\}} + \zeta_{jt} + \varepsilon_{ijt}$$

  Outside good $u_{i0t} = \varepsilon_{i0t}$

- Random Coefficient Logit Model: consumer heterogeneity $\left(\alpha_i^k, \beta_i^0, \beta_i^1\right) = \left(\alpha^k + \sigma_\alpha^k \nu_i^k, \beta^0 + \sigma_{\beta^0} \nu_i^{\beta_0}, \beta^1 + \sigma_{\beta^1} \nu_i^{\beta_1}\right)$
- Mean utility $\delta_{jt} = \sum_k \alpha^k x_{jt}^k - \beta_i^0 p_{jt} 1_{\{p_{jt} \leq \bar{p}_{jt}\}} - \beta_i^1 p_{jt} 1_{\{p_{jt} > \bar{p}_{jt}\}} + \zeta_{jt}$ and deviations from the mean utility $\mu_{ijt} = \sum_k \sigma_\alpha^k x_{jt}^k \nu_i^k - \sigma_\beta p_{jt} \nu_i^p$
- Assumption: ε_{ijt} iid and type I extreme value and ν_i follows $\varphi(.)$

$$s_{jt}\left(\mathbf{x}_t, \mathbf{p}_t, \zeta_t\right) = \int \frac{\exp\left(\delta_{jt} + \mu_{ijt}\right)}{1 + \sum_k \exp\left(\delta_{kt} + \mu_{ikt}\right)} \varphi\left(\nu_i\right) d\nu_i$$

Demand Estimation

- GMM estimation (BLP 1995, Nevo, 2000), using optimal IVs (BLP 1999, Reynaert and Verboven, 2013)
- Instrumental variables:
  - Hausman type IVs: prices in other markets (conditional on observed demand characteristics, cross market correlation in price of given product due to common cost factors rather than unobserved features of demand). Here, prices in UK, Germany, Italy and Spain but account for unobserved molecule-specific demand taste using residuals of regression of foreign prices on country, molecule and year dummies
  - BLP type IVs: nonprice characteristics of competing products which proxy for the degree of competition
  - Exchange rate shocks (affecting marginal costs of firms producing internationally while pricing in local currency)
  - Country specific input prices (producer price index for pharmaceuticals from BLS, INSEE, Eurostat), pharmaceutical industry wages
- Robustness checks with respect to market size, optimization, random draws, IVs.

Random Coefficient Logit Estimates

Table 4—Estimation Results of Random Coefficient Logit Model

	France		Germany		US	
	Mean	Sigma	Mean	Sigma	Mean	Sigma
Price			−5.50	3.00	−4.06	2.97
			(1.50)	(1.87)	(1.36)	(1.52)
Price below TFR ($p_{jt} \times \mathbf{1}_{[p_{jt} \le p_j^{tfr}]}$)	−6.95	6.62				
	(2.70)	(3.25)				
Price above TFR ($p_{jt} \times \mathbf{1}_{[p_{jt} > p_j^{tfr}]}$)	−18.73	6.83				
	(6.24)	(1.38)				
Detailing	0.27		0.17		0.05	
	(0.11)		(0.04)		(0.14)	
Branded	2.44	1.07	2.81	0.27	6.31	3.10
	(1.37)	(3.17)	(1.39)	(0.80)	(4.91)	(1.55)
Nb. formats	0.49		0.38		1.40	
	(0.30)		(0.25)		(0.55)	
Generic × nb. formats	1.90		1.48		0.02	
	(0.48)		(0.29)		(0.99)	
Nb. side effects	−0.25		0.02		−0.39	
	(0.07)		(0.19)		(0.14)	
Generic × nb. side effects	−0.05		−0.22		0.57	
	(0.19)		(0.19)		(0.79)	
Helicobacter indication	1.36		1.73		3.58	
	(0.26)		(0.42)		(0.78)	
NSAID indication	0.61		0.46		0.18	
	(0.29)		(0.16)		(0.35)	
GERD indication	−1.44		−1.52		−1.58	
	(0.35)		(0.25)		(0.42)	
Year fixed effects	Yes		Yes		Yes	
Molecule fixed effects	Yes		Yes		Yes	

Price Elasticities for France

Table 5—Own- and Cross-Price Elasticities for Main Drugs, 2009 (*France*)

	Branded						Generic	
Subclass	H2	H2	PPI	PPI	PPI	Prost.	H2	PPI
Company	Aptalis	Glaxo	AstraZ.	AstraZ.	Takeda	Pfizer	Mylan	Mylan
Molecule	Cimet.	Ranit.	Omep.	Esom.	Lanso.	Miso.	Ranit.	Omep.
Drug name	Tagamet	Zantac	Losec	Nexium	Takepron	Cytotec		
Tagamet	−6.96	2.84	0.003	0.23	0.05	0.01	0.02	0.14
Zantac	0.71	−5.62	0.002	0.19	0.04	0.01	0.02	0.13
Losec	0.00	0.00	−5.48	1.64	0.16	0.00	0.003	0.05
Nexium	0.00	0.00	0.19	−3.90	0.25	0.005	0.01	0.14
Takepron	0.00	0.00	0.13	1.73	−5.24	0.01	0.01	0.16
Cytotec	0.002	0.01	0.01	0.81	0.17	−2.45	0.02	0.16
Ranit. Mylan	0.001	0.003	0.02	0.68	0.13	0.01	−3.00	0.23
Omep. Mylan	0.001	0.002	0.04	0.91	0.16	0.01	0.03	−3.68

Notes: Each column is the price elasticity of demand for the drug in the first row with respect to the drug named in the first column. Company names: Glaxo is GlaxoSmithKline. AstraZ. is AstraZeneca. Molecules: Ranit. is Ranitidine; Omep. is Omeprazole; Esom. is Esomeprazole; Lanso. is Lansoprazole; Miso. is Misoprostol.

Structural Estimation of Price-Cost Margins

- What are the reasons of price decrease: regulation? changing demand? changing marginal costs?
- We estimate price cost margins assuming firms pricing is not constrained in US and Germany and for some drugs and years in France and allow previous group of drugs to be potentially constrained
- Need impose cost restrictions across constrained and unconstrained markets:
  - assume marginal cost is sum of active ingredient specific effect, a brand type effect and an uncorrelated additive deviation.
- Compare estimated margins with counterfactual margins under free pricing equilibrium

Model Estimates

TABLE 6—NLLS ESTIMATES OF λ_{jt} (*Normalized by Market Size*)

	All products		Products with λ_{jt} significantly positive				
	Number of products		Number of products		λ_{jt}	s_{jt}	$\sum_j s_{jt}$
Year	Branded	Generics	Branded	Generics	Mean	Mean	Mean
2003	12	11	1	5	0.00026	0.00105	0.00628
2004	12	27	1	9	0.00029	0.00183	0.01826
2005	12	28	1	3	0.00027	0.00084	0.00334
2006	12	30	2	5	0.00023	0.01168	0.08176
2007	12	37	3	10	0.00033	0.00904	0.11756
2008	12	36	1	6	0.00030	0.00127	0.00891
2009	12	47	0	11	0.00031	0.00138	0.01519
2010	12	50	1	11	0.00083	0.00318	0.03816
2011	12	62	2	26	0.00152	0.00634	0.17764
2012	12	74	4	36	0.00210	0.00626	0.25034
2013	11	83	3	47	0.00288	0.00858	0.42907

Price-Cost Margins for France

TABLE 7—AVERAGE PRICE-COST MARGINS BY MOLECULE (*France*)

		Not accounting for price regulation (%)			Accounting for price regulation (%)		
Subclass	Molecule	All drugs	Branded	Generic	All drugs	Branded	Generic
H2	Cimetidine	52	15	62	41	14	47
	Ranitidine	30	24	32	23	19	24
	Famotidine	28	10	36	20	9	26
	Nizatidine	18	18		14	14	
PPI	Omeprazole	29	22	30	22	14	23
	Esomeprazole	43	24	50	31	15	37
	Lansoprazole	39	20	45	29	14	34
	Pantoprazole	43	20	47	33	14	36
	Rabeprazole	45	18	60	33	13	43
Prost.	Misoprostol	47	47		37	37	
Combi.	Bismuth/ Antibiotic	27	27		21	21	

Notes: Margins as a percentage of price. Empty cells indicate that there is no generic version of the molecule named in the corresponding row. When not taking into account price regulation, we infer price cost margins as if firms were free to choose prices.

Average Price-Cost Margins by molecule for France

		Some price	All Drugs		Branded Drugs		Generic Drugs	
Sub-Class	Molecule	Constr. drug	Free	Constr.	Free	Constr.	Free	Constr.
H2	Cimetidine	Yes	87%	50%	61%	41%	94%	52%
	Ranitidine	Yes	44%	38%	38%	39%	45%	38%
	Famotidine	Yes	50%	38%	39%	27%	61%	42%
	Nizatidine	No	29%	26%	29%	26%		
PPI	Omeprazole	Yes	36%	33%	65%	39%	31%	33%
	Esomeprazole	No	54%	46%	54%	46%		
	Lansoprazole	Yes	33%	34%	23%	20%	52%	44%
	Pantoprazole	No	21%	21%	21%	21%		
	Rabeprazole	No	24%	23%	24%	23%		
Prost.	Misoprostol	No	122%	67%	122%	67%		

Counterfactual Simulations

- Results suggest regulation have constrained price setting of some drugs after 2004
- Investigate effect of such constraints on industry equilibrium
- Counterfactual simulation of free pricing in markets where price constraints have been modeled.
- Once marginal costs identified, simulate free pricing equilibrium.
- Remind that constraint can have direct and indirect effect on prices and quantities

Counterfactual Savings

Table 8—Counterfactual Savings and Surplus from Free Pricing

		2003	2006	2009	2012	2003–2013
Subclass	Molecule					
H2	Cimetidine	−913	−239	−28	−83	−2,120
	Ranitidine	−894	−578	−384	1133	−4,007
	Famotidine	−37	8	18	42	134
	Nizatidine	−4	1	3	6	5
PPI	Omeprazole	−469	1,916	2,111	13,091	59,149
	Lansoprazole	666	616	−468	3,853	9,973
	Pantoprazole	82	333	1,710	1,203	17,495
	Esomeprazole	1,672	−1,067	1,095	4,488	44,213
	Rabeprazole	407	389	−832	28,273	27,918
Prost.	Misoprostol	−277	−239	−181	−145	−2,375
Combi.	Bismuth/ Antibiotic					53
Total		234	1,140	3,044	51,860	150,439
Subtotal	Branded	382	1,903	4,107	30,389	88,242
	Generics	−148	−763	−1,064	21,471	62,197
Consumer surplus change		+1.1%	+1.3%	+2.6%	+10.2%	+15.4%

Notes: Savings are in 1,000 US\$. Negative numbers indicate increased expenditures compared to observed. Surplus

Price Cost Margins Identification with Constraints

- Method allows to estimate price-cost margins in regulated sector taking into account price constraints imposed by regulator on firms.
- Constraints are binding for some drugs, regulation reduces significantly margins and prices. Overestimation of margins otherwise.
- Accounting for regulation important when estimating mark-ups.
- Price regulation generates modest savings