Markups and Markdowns in the French Dairy Market

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Motivation

Market power (MP) is the ability of firms to set prices, *i.e*:

- to sell output at a high price, imposing a **markup**,
- to purchase input at a low price, imposing a **markdown**.

$\Rightarrow$ decreases welfare, generates misallocation, distorts VA sharing.

It is crucial to quantify and disentangle buyer and seller MP to identify:

- the magnitude of the inefficiency
- the source of the inefficiency

in order to design the proper public policies.

We focus on the market power of **French dairy manufacturers**.

Toy Model

Assume a profit-maximizing firm with technology $f(m) = m$, facing:

- inverse input supply $w(m)$,
- inverse output demand $p(y)$.

The firm chooses y^* to maximize $p(y)y - w(y)y$, and at the optimum:

$$\underbrace{p(y^*)\left(1 + \frac{p'(y^*)y^*}{p(y^*)}\right)}_{MR(y^*)} = \underbrace{w(y^*)\left(1 + \frac{w'(y^*)}{w(y^*)}y^*\right)}_{MC(y^*)}$$

and we can define

- markup $\mu \equiv \frac{p(y^*)}{MC(y^*)} = \frac{1}{1+\varepsilon_D^{-1}(y^*)}$
- markdown $\nu \equiv \frac{MR(y^*)}{w(y^*)} = 1 + \varepsilon_S^{-1}(y^*)$
- (total) margin $M \equiv \frac{p(y^*)}{w(y^*)} = \nu \times \mu = \frac{1+\varepsilon_S^{-1}(y^*)}{1+\varepsilon_D^{-1}(y^*)}$

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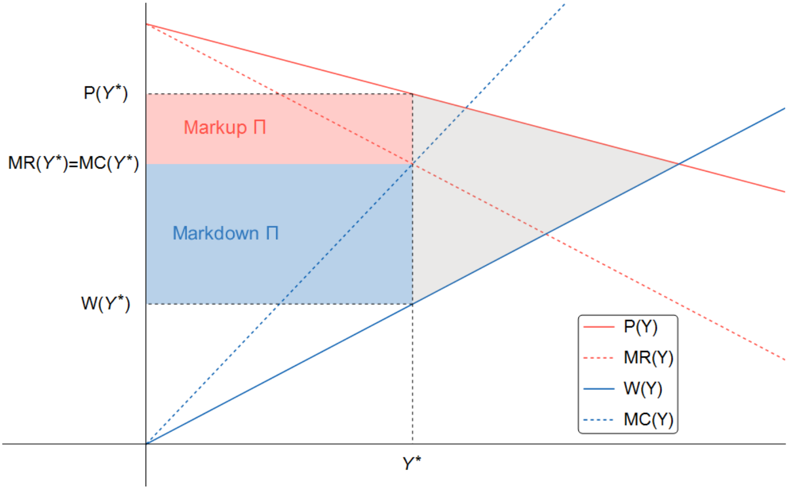

0MP DMP UMP Estimation

A Case Study - The French Dairy Industry

A market structure favoring market power

1. An asymmetrically concentrated supply chain. More
2. *Local* milk markets due to high transportation & transaction costs:
   - Milk typically processed at less than 60km from the farm.
   - Farmers constrained to sell to only 1 dairy firm.
   - Median local market (dept): 550 farms, 8 firms (Top 5 purchase 98%).
3. A product differentiation increasing along the production process:
   - relatively homogeneous raw milk and dairy intermediates,
   - differentiated final products.

Insufficient milk farmers revenues

- 42% of farms would have < 0 revenues absent public subsidies (2017).

Research Question

1. How big is the dairy manufacturers' market power?
2. What is the relative importance of markups and markdowns?
3. What are the consequences for the players of the supply chain?

Challenges

Disentangle both sources of market power in the presence of

- firms operating on multi-source & multi-product markets,
- heterogeneous and time-varying (2003-18) competition contexts.
  - upstream: quotas, price recommendations, contracting...
  - downstream: intervention prices, commercial reforms, purchasing alliances...

Given these features, we construct a model

- of **multi-source** and **multi-product** profit-maximizing dairy firms,
- with **limited assumptions on competition**,
  - increasing firm-source specific supply curves
  - decreasing firm-product specific demand curves
- assuming a particular (Leontief) **production function** (PF). More

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What we Do

Using unique data on:

- firm-location level prices & quantities of raw milk,
- the input/output matrix of milk transformation into dairy products,
- firm-product level (factory-gate) prices & quantities of dairy products,

our model allows us to estimate

1. Firm-product-source-year total margins,
   - relying on a PF approach to estimate marginal *processing* cost
2. The two contributors to these margins, namely:
   - firm-product-year markups,
   - firm-source-year markdowns,

   leveraging the existence of a *commodity*: whole milk powder (WMP)

   (i) *substitutable* with raw milk (resp. dairy products) as an input (output),

   (ii) traded on *global markets* $\Rightarrow$ no price-setting power.

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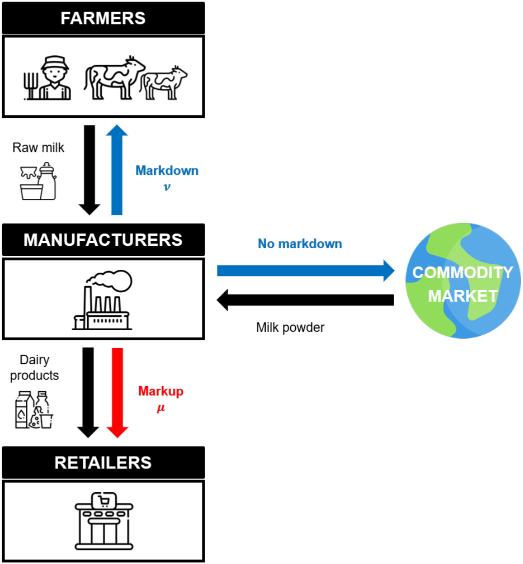
Identification Intuition (for commodity buyers)



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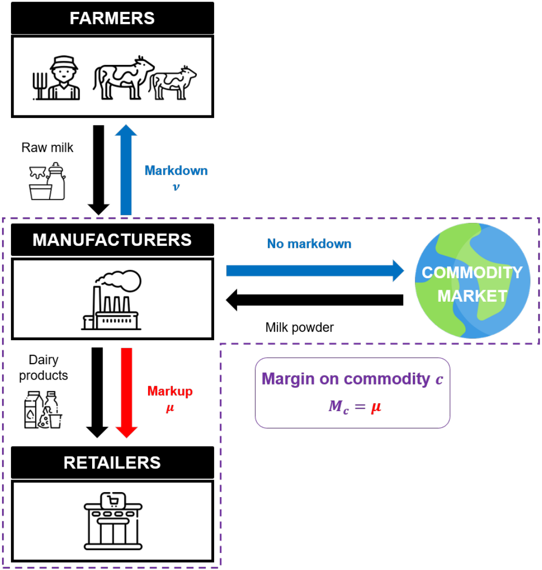

Margin on commodity c

$M_c = \mu$

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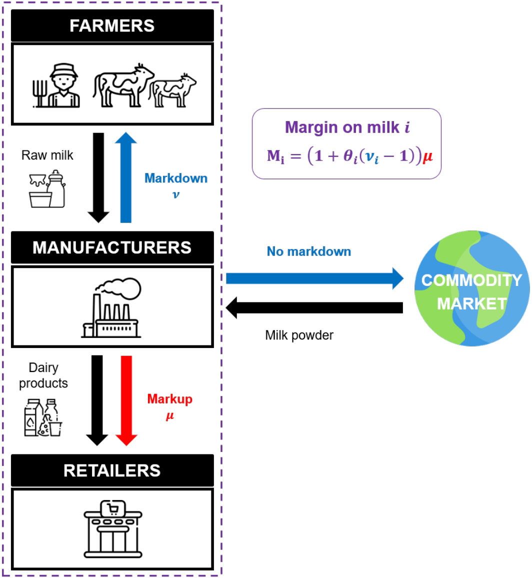

Results

We estimate an average total margin rate of 62% that we decompose into:

- an average markup rate of 46%,
- an average markdown rate of 19%. More
  - A PF approach ignoring buyer power would have lead to a 35% markups overestimation
  - Such estimated *markups* can be considered as *margins, emanating from buyer and seller powers*.

We show the importance of several heterogeneity dimensions as

- bigger firms charge higher markups, but not higher markdowns, Graphs
- high (low) markups on differentiated (homogeneous) products, Graph
- markups and markdowns vary over time. Next

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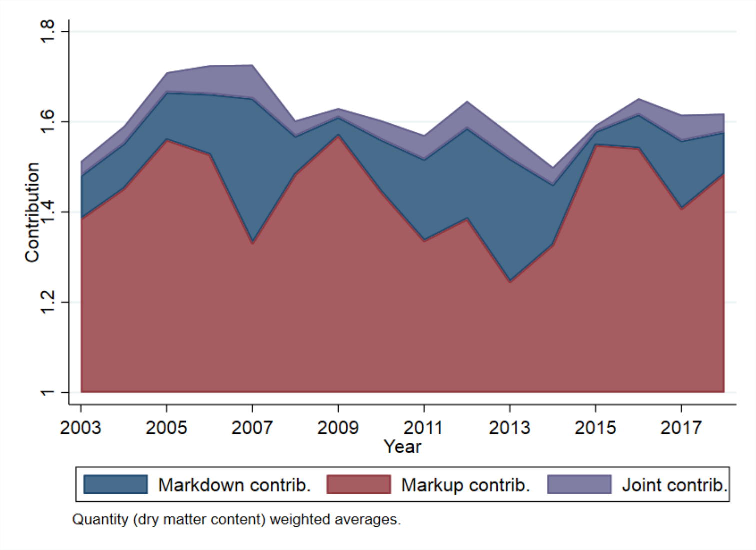
Margins, Markups and Markdowns over Time



Pass-through of Commodity Price Shocks through the Chain

Table: Pass-Through: Reduced-Form Estimates

	(1) Milk Price	(2) Output Price	(3) Markdown	(4) Markup	(5) Margin
WMP Price	0.393***	0.138***	0.639***	-0.537***	-0.110***
	(0.021)	(0.021)	(0.012)	(0.036)	(0.031)
Obs.	1,343	3,135	6,256	3,135	2,6547
R-squared	0.416	0.971	0.626	0.859	0.865

Standard errors are in parenthesis. **** p<0.01, ** p<0.05, * p<0.1*
Sample restricted to final goods and WMP buyers only. Fixed effects included.

We show:

- *incomplete pass-throughs* from commodity price shocks to prices,
- explained by **endogenous adjustments in MP exertion**,
  - as we move up (or down) along supply and demand curves
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Conclusion (1/2) - Policy

Buyer power:

- transfers VA from farmers to manufacturers $\approx$ 1 billion €/year
  - $\approx$ annual milk farmers' CAP subsidies $\rightarrow$ captured by manufacturers
- impedes farms from benefiting of good conjecture times.
- has possible remedies:
  - setting a price floor on raw milk,
  - promoting farmers' countervailing power.
  - Farmers' and consumers' interests are aligned!

Seller power:

- transfers VA from retailers/consumers to manuf. $\approx$ 5 billions €/year
- questions the role of retailers:
  - insufficient countervailing buyer power,
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- questions current competition policies' efficiency.

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Conclusion (2/2) - Methodology

We suggest a new way of disentangling buyer and seller power:

- exploiting the existence of *commodity* markets,
  - practical tool for other contexts, even if limited data!
- which does not require demand/supply estimation,
  - allowing a wide range of behaviors, e.g. collusion, vertical cooperation;
  - especially suitable for studying MP in food supply chains.

Thank you!

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No MP

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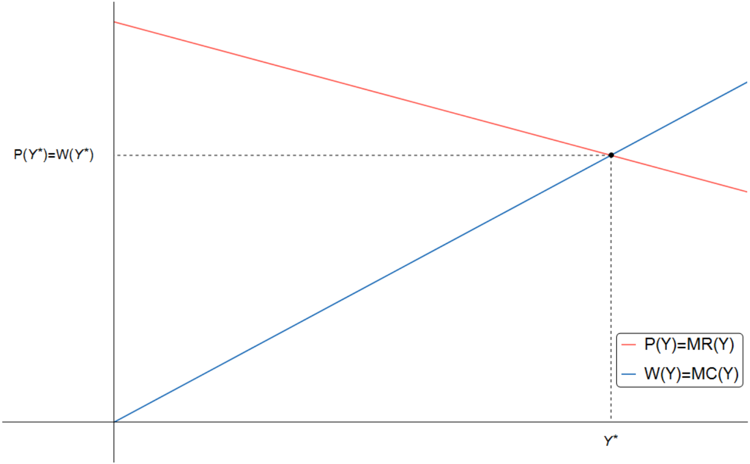

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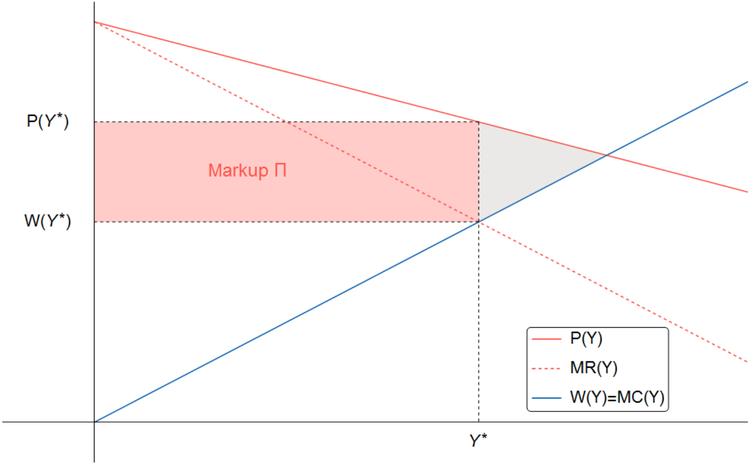
Downstream MP

$$p(y)\left(1+\frac{p'(y)y}{p(y)}\right)=w(y)\Leftrightarrow \text{Markup } \mu\equiv\frac{p(y)}{MC(y)}=\frac{p(y)}{w(y)}=\frac{1}{1+\varepsilon_D^{-1}}$$



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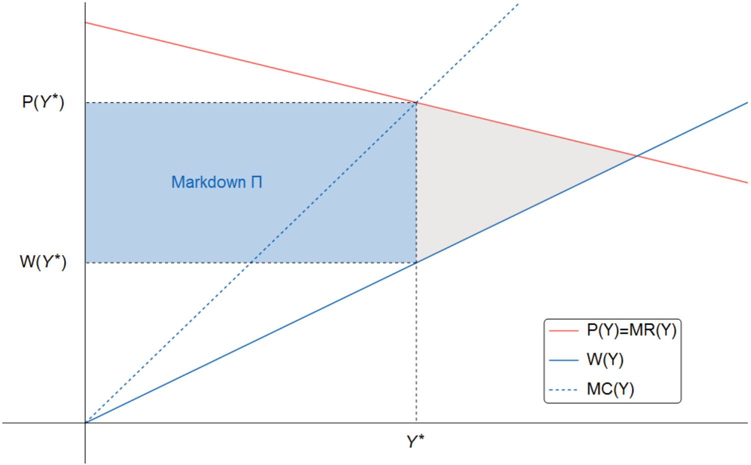
Upstream MP

$$p(y) = w(y)\left(1 + \frac{w'(y)}{w(y)}y\right) \Leftrightarrow \text{Markdown } \nu \equiv \frac{MR(y)}{w(y)} = \frac{p(y)}{w(y)} = 1 + \varepsilon_S^{-1}$$



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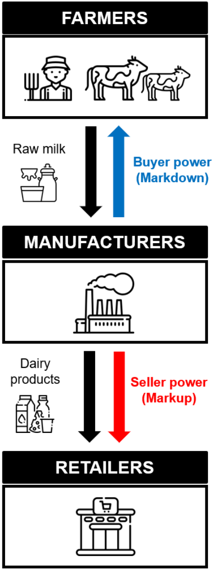
Toy Model

Insights:

1. Markups & markdowns reduce consumers' and farmers' surplus.
2. Ignoring one side of MP may lead to underestimate welfare losses.
3. Misidentifying their respective roles can bias policy recommendations.

The French Dairy Supply Chain (2018)



54,000 dairy farms

- Top 5: 0.1% of raw milk sales

300 manufacturers (groups)

- Top 5: 63% of raw milk purchases

Retailers

- Top 5: 80% of food purchases (FR)

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Fact 2: Buyer Power

Table: Competition on the Raw Milk Market (2018)

	Number of ...		Collection Share (%) of Top ...					
	Buyers	Farms	1	2	3	4	5	10
At the national level								
	300	54,000	21	41	52	58	63	75
At the departmental level								
Median	8	406	46	73	88	95	98	100
Average[a]	13	1,588	43	67	81	89	93	98

[a] Quantity weighted average.

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Fact 3: Seller Power.

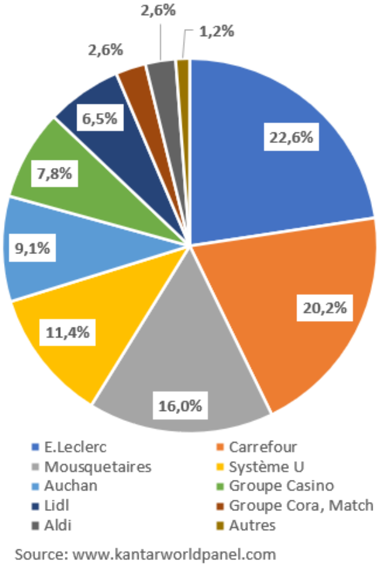
Table: Competition on the Dairy Products Market (2018)

	Number of ...	Market Share (%) of Top ...					
	Sellers	1	2	3	4	5	10
At the national level							
	300	21	41	52	59	66	79
At the product level							
Median	40	24	42	56	65	72	92
Average[a]	58	25	44	56	66	74	89

[a] Revenue weighted average.

Retail Back

Food Market Shares - Retailers



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Production Function

Firm f produces output j combining milk inputs i with labor and capital.

$$y_{fj} = \min \left\{ \underbrace{\sum_i e_{ij} m_{fij}}_{\text{required milk inputs}}, \underbrace{F_j \left(L_f, K_f; \Omega_f \right)}_{\text{processing function}} \right\}$$

- Milk inputs
  - m_{fij} is the quantity of milk input i used to produce j,
  - $e_{ij} \equiv e_i / e_j$ is the quantity of m_{ij} needed to produce a unit of y_j. More
- Processing function F_j
  - L_f and K_f are firm's quantities of labor and capital,
  - Ω_f is a vector of firm's f efficiencies for processing different products.

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Literature

- Markups:
  - *PF approach*: De Loecker and Warzynski (2012); De Loecker et al. (2016); De Loecker and Eeckhout (2018)
  - *Demand approach*: Berry et al. (1995); Nevo (2001)
  - *PF & Demand*: De Loecker and Scott (2016)
- Markdowns:
  - on labor: Brooks et al. (2021); Yeh et al. (2022); Berger et al. (2022)
  - on materials: Morlacco (2020); Zavala (2020); Bartkus et al. (2021)
- Markups & Markdowns: Rubens (2021)

Contributions:

- Estimating **multidimensional** markups **and** markdowns:
  - new method for disentangling both, relevant for agri-food industries.
- Assessing the bias of ignoring buyer power in markups estimation (PF).
- Documenting VA sharing between farmers and manufacturers.

Back

Data (2003-2018)

- Enquête Annuelle Laitière & PRODCOM:
  - Output side, **firm-product-time level**
    - quantities of dairy products sold,
    - factory-gate prices.
  - Input side, **firm-department-time level**
    - quantities of raw milk purchased,
    - raw milk prices, for a sub-sample and from 2013 to 2018.
- Sondage Onilait:
  - Average raw milk prices, **region-time level** from 2000 to 2018
- CNIEL data: dry matter content of
  - dairy products, **product level**
  - raw milk, **department-time level**
- FICUS-FARE:
  - capital & labor inputs, **firm-time level**

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Whole Milk Powder as a Competitive Input/Output

- Why a bulk product?
  - sold on global commodity markets $\Rightarrow$ no buyer/seller power,
  - perfectly substitutable with milk, conditional on dry matter e_b and e_i.
- Why this one?
  - fat and proteins contents very similar to raw milk,
  - used in many products (yoghurts but also milk or cheese!).
- When is the flexible input/output assumption relevant?
  - input: when a firm uses bulk product for at least one of its products,
  - output: when a firm produces at least one bulk product.
- Limitations:
  - processing costs may differ,
  - WMP easier to transport and store,
  - lagging/smoothing world prices?

Back

Variable Profit Maximization

Each dairy firm maximizes variable profit under the previous PF:

$$\max_{m_{fij}, L_f} \quad \Pi_f = \sum_j p_{fj}(y_{fj}) y_{fj} - \sum_i w_{fi}(m_{fi}) m_{fi} - w_f L_f$$

where $m_{fi} = \sum_j m_{fij}$, and the main assumptions on competition are:

- a decreasing firm-product specific demand curve $p_{fj}(.)$, Relax
- an increasing firm-department specific supply curve $w_{fi}(.)$, More

★ **Nash-Equilibrium:** no profitable unilateral deviation ★

Timing Back

First Order Conditions

Rewriting the program, the FOC for every m_{fij} yields:

$$\underbrace{p_{fj}\left(1+{\varepsilon_{fj}^{D}}^{-1}\right)}_{\text{marginal revenue } MR_{fj}} = \underbrace{\left(1+{\varepsilon_{fi}^{S}}^{-1}\right)\frac{w_{fi}}{e_{ij}}+\lambda_{fj}}_{\text{marginal cost } MC_{fj}}$$

where we defined:

- λ_{fj} as the marginal processing cost (MPC) of milk used in product j,
- the demand price-elasticity of j as

$$\varepsilon_{fj}^{D} \equiv \frac{\partial y_{fj}}{\partial p_{fj}}\frac{p_{fj}}{y_{fj}},$$

- the supply price-elasticity as

$$\varepsilon_{fi}^{S} \equiv \frac{\partial m_{fi}}{\partial w_{fi}}\frac{w_{fi}}{m_{fi}}.$$

Back

Margin

Definition

The margin measures the ability of a firm to set a price above its *accounting* marginal cost (AMC).

We define the margin of firm f on product j sourcing milk from input market i as:

$$M_{fij} \equiv \frac{p_{fj}}{\frac{w_{fi}}{e_{ij}} + \lambda_{fj}}.$$

Back

Markdown

Definition

The markdown measures the ability of a firm to purchase a milk input at a price below the input's marginal contribution to profit.

We define the markdown of firm f on input i used for producing j as:

$$\nu_{fi} \equiv \frac{e_{ij}\left(p_{fj}\left(1+{\varepsilon_{fj}^{D}}^{-1}\right)-\lambda_{fj}\right)}{w_{fi}} = 1+{\varepsilon_{fi}^{S}}^{-1}.$$

Back

Markup

Definition

The markup measures the ability of a firm to set a price above its marginal cost (MC).

We define the markup of firm f on product j as:

$$\mu_{fj} \equiv \frac{p_{fj}}{\left(1 + \varepsilon_{fi}^{S^{-1}}\right) \frac{w_{fi}}{e_{ij}} + \lambda_{fj}} = \frac{1}{1 + \varepsilon_{fj}^{D^{-1}}}.$$

Back

Main Assumptions

Theory

- Production function
  - perfect complementarity milk vs. (labor,capital),
  - perfect substitutability (cond. on DMC) between milk from different locations (within firm's accessible range).
- Cost minimization (Profit maximization)
  - increasing milk supply curve,
  - perfectly variable inputs: milk, labor,
  - (+ decreasing demand curve).

Estimation

+ firm-level marginal processing costs,
+ perfect substitutability of WMP with
  - milk as an input (must hold for at least one of the firm's product),
  - other products as an output.
+ exogenous WMP price.

Back

Margin Decomposition

The margin can be rewritten:

$$M_{fij} = \left(\theta_{fij}\nu_{fi} + (1-\theta_{fij})\right)\mu_{fj}$$

where $\theta_{fij} \equiv \frac{w_{fi}}{w_{fi}+e_{ij}\lambda_{fj}}$ is the share of milk from i in the AMC of j.

- Without upstream market power ($\nu_{fi} = 1$), the margin reduces to:

$$M_{fij} = \mu_{fj}$$

- Without downstream market power ($\mu_{fj} = 1$), the margin becomes:

$$M_{fij} = 1 + (\nu_{fi} - 1)\theta_{fij}$$

Recovering Margins

1. We need to estimate marginal processing costs to recover margins:

$$M_{fij} \equiv \frac{p_{fj}}{AMC_{fij}} = \frac{p_{fj}}{\frac{w_{fi}}{e_{ij}} + \lambda_{fj}}$$

2. We then need to find a way to disentangle markups and markdowns:

$$M_{fij} = \left(\theta_{fij}\nu_{fi} + (1-\theta_{fij})\right)\mu_{fj}$$

where $\theta_{fij} \equiv \frac{w_{fi}}{w_{fi}+e_{ij}\lambda_{fj}}$ is the share of milk from i in the AMC of j.

All other terms are observed, including e_{ij}. More

Back 2MP

Marginal Processing Cost Identification

- Assumption: $\lambda_{fj} = \lambda_f \ , \ \forall j$
- Identification:
  - Minimization of variable cost given desired quantity $y_f^* = \sum_j y_{fj}$:

$$\begin{aligned} \min_{l_f} \quad & w_f l_f \\ \text{s.t.} \quad & F(l_f, k_f, \omega_f) - y_f^* \geq 0, \end{aligned}$$

At the optimum, we have:

$$\lambda_f = \frac{w_f}{\frac{\partial F(l_f, k_f, \omega_f)}{\partial l_f}} = \frac{w_f l_f^*}{\varepsilon^{Y,L} y_f^*}.$$

$\Rightarrow$ We thus need to estimate the processing function!

Processing Function Estimation

We assume a translog PF and thus have the estimating equations:

$$y_{ft} = \beta_l l_{ft} + \beta_k k_{ft} + \beta_{ll} l_{ft}^2 + \beta_{kk} k_{ft}^2 + \beta_{kl} k_{ft} l_{ft} + \omega_{ft} + \epsilon_{ft}$$

where:

- ϵ_{ft} = i.i.d. error on which the firm does not act
- ω_{ft} = firm-specific technical efficiency, observed by the firm, not by us.

3 challenges raised by the literature:

1. ω_{ft} unobserved source of endogeneity
   - productivity inversion More
2. Market power upstream and downstream
   - MP controls More
3. l_{ft} and k_{ft} imperfectly observed
   - Controls More

Estimation

Overall, the PF can be re-written as:

$$\begin{aligned} y_{ft} = &\beta_l l_{ft} + \beta_k k_{ft} + \beta_{ll} l_{ft}^2 + \beta_{kk} k_{ft}^2 + \beta_{kl} k_{ft} l_{ft} \\ &+ f\left(h(k_{ft-1}, l_{ft-1}, m_{ft-1}, s_{ft-1}^m, s_{ft-1}^y)\right) + \epsilon_{ft} + e_{ft} \end{aligned}$$

We estimate this equation

- by GMM,
- instrumenting l_{ft} with l_{ft-1}, as e_{ft} is correlated with l_{ft} (not with k_{ft}),
- approximating $f(h(.))$ by a 2^{nd} order polynomial.

Processing Function Estimates

	OLS	GMM - CD	GMM - TL
β_l	0.534***	0.739***	0.585***
	(0.035)	(0.035)	(0.145)
β_k	0.252***	0.138***	0.121
	(0.027)	(0.021)	(0.083)
β_{ll}			0.098***
			(0.029)
β_{kk}			0.066***
			(0.018)
β_{kl}			-0.149***
			(0.044)
Obs.	7,996	7,996	7,996
R2	0.974		
Labor Quality corr.	No	Yes	Yes
Market Power corr.	No	Yes	Yes
Firm and Year F.E.	Yes	Yes	Yes

Labor Elasticities

Remember the Translog PF delivers firm-time specific labor elasticities:

$$\varepsilon_{ft}^{Y,L} \equiv \varepsilon^{Y,L}(l_{ft}, k_{ft}) = \beta_l + 2\beta_{ll} l_{ft} + \beta_{kl} k_{ft}$$

Table: Distribution of Labor Elasticities

	Average	Median	P5	P25	P75	P95	Obs.
Labor Elasticity	0.79	0.79	0.65	0.73	0.86	0.95	2,736
Capital Elasticity	0.14	0.14	0.01	0.09	0.19	0.24	2,736

More

The Choice of the Flexible Input/Output

Our *flexible input/output*:

Bulk Whole Milk Powder (WMP)

- Why a bulk product?
  - sold on global markets with a quotation price $\Rightarrow$ no buyer/seller power,
  - perfectly substitutable with milk, conditional on dry matter e_b and e_i.
- Why this one?
  - fat and proteins contents very similar to raw milk,
  - used in many products (yoghurts but also milk or cheese!).
- When is the flexible input/output assumption relevant?
  - input: when a firm uses bulk product for at least one of its products,
  - output: when a firm produces at least one bulk product.

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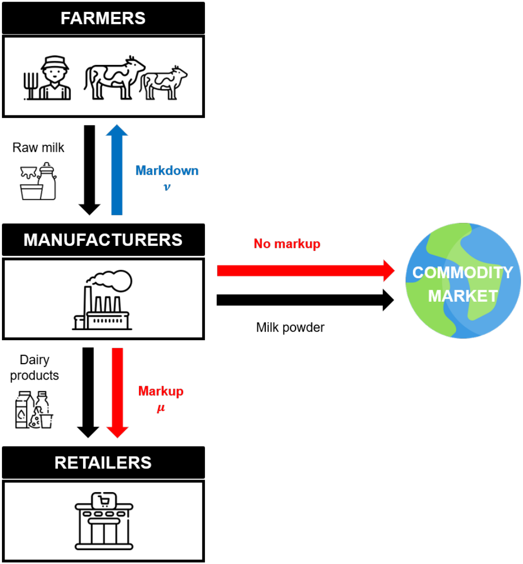
Identification for Commodity Sellers



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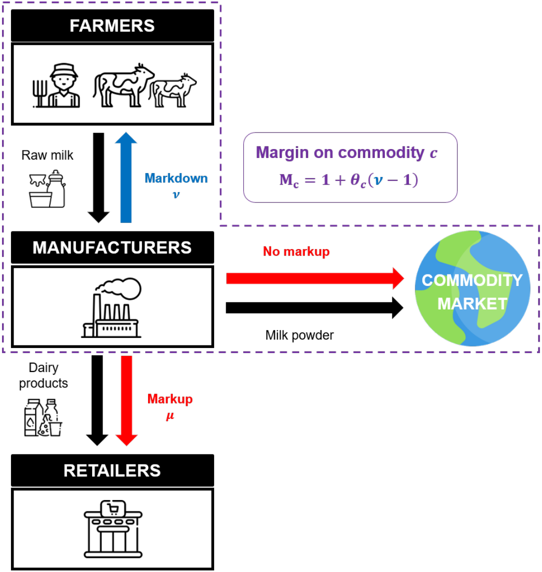
Identification for Commodity Sellers



Margin on commodity c

$$\mathbf{M_c} = 1 + \theta_c(\nu - 1)$$

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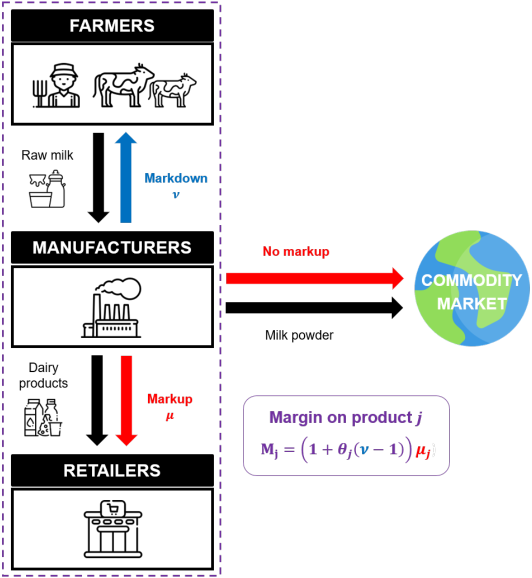
Identification for Commodity Sellers



Margin on product *j*

$$M_j = \left(1 + \theta_j(\nu - 1)\right)\mu_j$$

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Margins, Markdowns and Markups - Estimates

Table: Markdowns, Markups and Margins - Estimates

	Markdowns	Markups		Margins	
Sample	All	All prod.	Final prod.	All prod.	Final prod.
Average	1.18	1.31	1.66	1.55	1.83
Weighted Average	1.18	1.47	1.69	1.64	1.82
Median	1.15	1.17	1.60	1.48	1.84
Observations	8,049	8,917	5,623	75,788	47,360

Notes: Sample restricted to firms for which we manage to link raw milk collection and production. Markdowns computed based on raw milk prices at the regional level. Weighted averages based on quantity (dry matter content) shares upstream and downstream.

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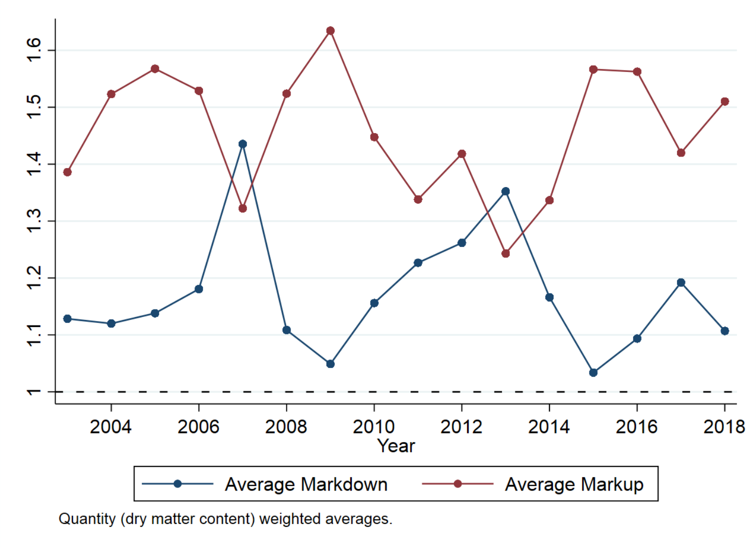
Markups and Markdowns



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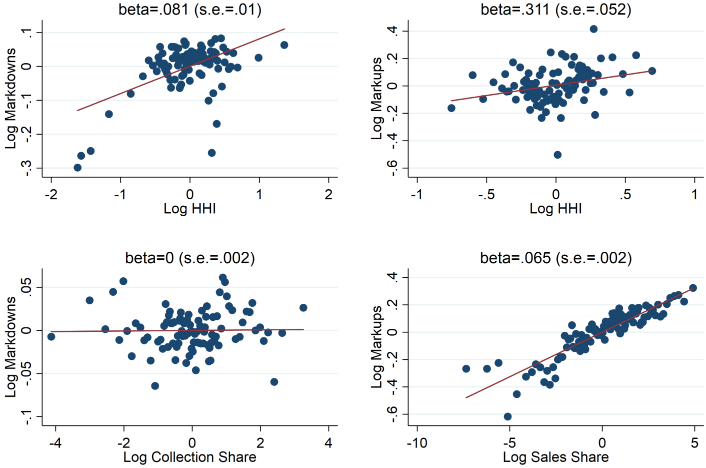
Markups, Markdowns, Competition and Market Shares



Obs. at the market-time (up) and group-market-time level (bottom), grouped into 100 equal-sized bins in terms of the X-axis var. Variables de-meaned by time on the up left-hand graph, by market and time on the up right-hand graph, and by market-time on the two bottom graphs.

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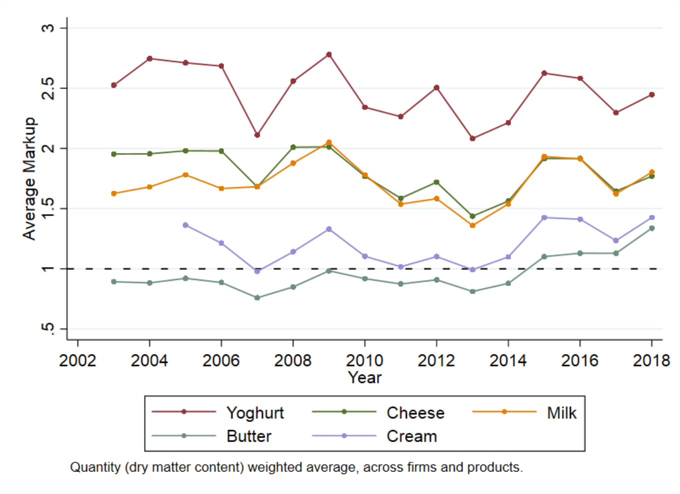
Markups on Final Consumption Goods - Product Category Averages



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Timing Assumption: Firms proceed in two stages

Stage 1 : Market Positioning, which determines

- A_{fj}, the competitive environment of firm f on output j.
  - Products range, distribution network, quality choice, rivals' strategies, demand shocks...
- A_{fi}, the competitive environment of firm f on input i.
  - Plant(s) location(s), sourcing strategies, rivals' strategies, supply shocks...

Stage 2 : Variable Profit Maximization [OUR FOCUS]

- Each firm knows its own demand and supply functions $\forall\ i, j$:
  - $p_{fj}(y_{fj}, Y_{f-j}, A_{fj})$ is the inverse demand of firm f on product j.
  - $w_{fi}(m_{fi}, A_{fi})$ is the inverse supply of firm f on department i.
- Each firm statically maximizes its variable profit.

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Dry Matter Contents e_i and e_j

Idea:

- Milk inputs = bundle of sub-inputs, mainly fat & proteins
- Quantity of milk needed for a unit of j: e_j = fat + proteins in j
- Quality of raw milk from i: e_i = fat + proteins in milk input from i

CNIEL data	Butter	Comté	Yoghurt	Raw Milk (i=25)
Content (in g/100g)				
Fat	82.00	31.20	2.69	3.95
Proteins	0.75	27.97	3.60	3.38
Dry Matter (e_j or e_i)	82.75	59.17	6.29	7.33
Quantity of milk needed (in g/g)				
e_{ij}	11.29	8.07	0.85	

Back (PF) Back (Est.)

Translog Elasticities and Input Shares

	Average	Median	P5	P25	P75	P95	Obs.
Labor Elasticity	0.79	0.79	0.65	0.73	0.86	0.95	2,736
Capital Elasticity	0.14	0.14	0.01	0.09	0.19	0.24	2,736
Labor Share in Processing Costs	0.73	0.73	0.57	0.66	0.80	0.90	2,736
Capital Share in Processing Costs	0.27	0.27	0.10	0.20	0.34	0.43	2,736

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