How Costly Are Cartels?

Flavien Moreau and Ludovic Panon
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Motivation

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- Cost of markups: large and growing (Edmond et al., 2018; Baqaee and Farhi, 2020; De Loecker et al., 2021)
- Less agreement on sources and importance of distortions generating these markups
- We study collusion and trace its aggregate impact on the economy
  - *"The idea that **cartels** might reduce industry productivity by **misallocating** production from high to low productivity producers is as old as Adam. While the idea has stood the test of time, it has done little else."* Bridgman et al. (2015)

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This Paper

1. Parsimonious but flexible macro model of cartels
   - Atkeson and Burstein (2008) meets O'brien and Salop (1999): heterogenous firm model with endogenous markups and cartels
   - Cartels $\Longrightarrow$ Δ markup dispersion $\Longrightarrow$ Δ aggregate productivity and welfare
2. Quantify effect of cartels
   - French micro data
   - Cost of markups changes with collusion!
   - (Static) cost of cartels is high

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Findings

- Cartels are frequent and made up of large firms
- Breaking down cartels could generate large gains
  - **Productivity** ↑ by 1%
  - **Welfare** ↑ by 2%
  - **Distance** to the **efficient** allocation ↓ 30%
- Lower intensity of collusion yields sizeable gains
- Productivity (welfare) **cost** of **markups** is 70% (58%) **larger** with collusion

Related Literature

- **Misallocation and aggregate TFP**
  - Hsieh and Klenow (2009); Edmond et al. (2015, 2022); Baqaee and Farhi (2020)
  - Contribution: collusion as an **extra** source of misallocation
- **Markups in macroeconomics**
  - Gutierrez and Philippon (2018); Autor et al. (2020); De Loecker et al. (2020, 2022)
  - Contribution: **quantify** loss from collusion
- **Cross-ownership**
  - O'brien and Salop (1999); Azar et al. (2018); Ederer and Pellegrino (2021)
  - Contribution: Aggregate **productivity** effects; **cost of markups** with collusion
- **Theory and empirics of cartels**
  - Levenstein and Suslow (2006, 2011); Bos and Harrington (2010, 2015); Bridgman et al. (2015); Asker et al. (2019)
  - Contribution: **misallocation** from **macro** perspective

Data

Data

1. **Decisions of *Autorité de la Concurrence* (French Competition Authority)** Decisions Firms
   - Focus on all anti-competitive cases over 1994-2019 covering 1994-2007 Institutional Details
   - 1371 anti-competitive cases investigated, **174 cartels convicted**
   - Fines, sales, type of anti-competitive practice, duration, number of firms in cartel Example Firms Example Duration/Type
2. **Firm-level administrative data**
   - Universe of French firms over 1994-2007 Cleaning

Median # Cartel Members: 4

	Mean (1)	Std. Dev. (2)	Median (3)	Min (4)	Max (5)
Duration (years)	4.49	5.74	3	1	47
# Firms per cartel	**6.3**	7.4	**4**	2	76
Price fixing	0.35	0.48	0	0	1
Market allocation	0.29	0.46	0	0	1
Production quotas	0.04	0.2	0	0	1
Information sharing	0.59	0.49	1	0	1
Repeat offender	0.08	0.27	0	0	1
Bid rigging	0.40	0.49	0	0	1
Dominant leader	0.04	0.2	0	0	1
Abuse of dominant position	0.03	0.18	0	0	1
Guaranteed buy-backs	0.07	0.25	0	0	1
Exclusive dealing contracts	0.18	0.38	0	0	1
# Cartels			174		
# Colluders			1,037		

Cartels Are Prevalent

Cartels by Sector (2007)

NAF (1)	Sector (2)	Sales Share (3)	VA Share (4)	# Cartels (5)	# Colluding Firms (6)
01-05	Agriculture, hunting, forestry, fishing	0.0013	0.0019		
10-14	Mining and quarrying	0.0033	0.0047	1	2
15-16	Food products, beverages and tobacco	0.0553	0.0534	3	19
17-19	Textiles, leather and footwear	0.0136	0.0143	1	1
20	Wood and wood products	0.0048	0.0051	1	8
21-22	Pulp, paper, publishing and printing	0.0227	0.0260	1	4
23	Coke	0.0237	0.0260	1	4
24	Chemicals	0.0435	0.0403	2	9
25	Rubber and plastics	0.0151	0.0169	2	3
26	Other non-metallic mineral prod.	0.0109	0.0133	3	12
27-28	Basic metals and fabricated metal prod.	0.0362	0.0412	2	9
29	Machinery and equipment n.e.c.	0.0250	0.0265	2	7
30-33	Electrical and optical equipment	0.0378	0.0410	2	4
34-35	Transport equipment	0.0533	0.0406	1	2
36-37	Other manufacturing n.e.c	0.0102	0.0107	2	3
40-41	Electricity, gas and water supply	0.0285	0.0428		
45	Construction	0.0596	0.0758	7	42
50-52	Wholesale and retail	0.3518	0.1872	11	69
55	Hotels and restaurants	0.0198	0.0310	1	3
60-63	Transport and storage	0.0472	0.0552	5	27
64	Post and telecommunications	0.0236	0.0503	1	2
70	Real estate activities	0.0140	0.0222	2	2
71-74	Renting and business activities	0.0722	0.1246	8	16
80	Education	0.0016	0.0029		
85	Health and social work	0.0078	0.0157	1	9
90-93	Other service activities	0.0173	0.0304	3	5

Model

Oligopolistic Competition

- Firms: **large** in their sector, **small** in the aggregate economy (Neary, 2003; Atkeson and Burstein, 2008)
- **Continuum** of sectors s

$$c = \left[\int_0^1 y_s^{\frac{\eta-1}{\eta}} ds \right]^{\frac{\eta}{\eta-1}}$$

- **Finite** number of firms K_s in each sector

$$y_s = \left[\sum_{k=1}^{K_s} (q_{sk})^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}}$$

- More substitution **within** than between sectors: $1 < \eta < \rho$

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- More substitution **within** than between sectors: $1 < \eta < \rho$

- Firms differ by productivity z_{sk}
- Static game of quantity competition (Cournot)
- Subset of firms in sector s belong to a cartel $\mathcal{C}$: $\emptyset \subseteq \mathcal{C}_s \subseteq K_s$
  - Horizontal cartels
  - **No** endogenous cartel formation

Cartel Members

- Distorted objective function for cartel members:

$$\pi_k^{\mathcal{C}} \propto \pi_k + \sum_{j \in \mathcal{C} \setminus \{k\}} \underbrace{\kappa_{kj}}_{\text{Intensity of collusion}} \pi_j \tag{1}$$

  - Common ownership framework (O'brien and Salop, 1999) ▸ Micro-foundation

- Cartel members solve

$$\max_{q_{sk}} \left[\left(P_{sk} - \frac{W}{z_{sk}} \right) q_{sk} + \sum_{j \in \mathcal{C} \setminus \{k\}} \kappa_{kj} \left(P_{sj} - \frac{W}{z_{sj}} \right) q_{sj} \right], \quad \forall k \in \mathcal{C}_s \tag{2}$$

subject to:

$$\left(\frac{P_{sk}}{P} \right) = \left(\frac{q_{sk}}{y_s} \right)^{-\frac{1}{\rho}} \left(\frac{y_s}{c} \right)^{-\frac{1}{\eta}} \tag{3}$$

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Heterogenous Markups

- **Competitive** firms: markups μ_{sk} depend on own market share $\omega_{sk} := \frac{P_{sk}q_{sk}}{\sum_{j=1}^{K} P_{sj}q_{sj}}$

$$\begin{aligned} \mu_{sk} &= \frac{\varepsilon_{sk}}{\varepsilon_{sk} - 1} \\ \varepsilon_{sk} &= \left[\frac{1}{\rho} + \left(\frac{1}{\eta} - \frac{1}{\rho}\right)\omega_{sk}\right]^{-1} \end{aligned} \tag{4}$$

- **Cartel members**' demand elasticities:

$$\varepsilon_{sk}^{\mathcal{C}} = \left[\frac{1}{\rho} + \left(\frac{1}{\eta} - \frac{1}{\rho}\right)\left(\omega_{sk} + \sum_{j \in \mathcal{C}\setminus\{k\}} \kappa_{kj}\omega_{sj}\right)\right]^{-1} \tag{5}$$

  - **Lower** demand elasticity $\Longrightarrow$ **supracompetitive markups**

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Markups by Types of Collusion

1. Competitive Nash-Cournot ($\kappa_{kj} = 0$):

$$\mu_{sk}^{\mathcal{C}} = \left[\frac{\rho - 1}{\rho} + \left(\frac{\eta - 1}{\eta} - \frac{\rho - 1}{\rho} \right) \omega_{sk} \right]^{-1}$$

2. Symmetric Collusion ($\kappa_{kj} = \kappa$):

$$\mu_{sk}^{\mathcal{C}} = \left[\frac{\rho - 1}{\rho} + \left(\frac{\eta - 1}{\eta} - \frac{\rho - 1}{\rho} \right) \left((1 - \kappa)\, \omega_{sk} + \kappa \omega_s^{\mathcal{C}} \right) \right]^{-1}, \quad \omega_s^{\mathcal{C}} = \sum_{j \in \mathcal{C}} \omega_{sj}$$

3. Full Collusion ($\kappa_{kj} = 1$):

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- Log change in markups at the first order:

$$\hat{\mu}_{sk}^{\mathcal{C}} = \underbrace{\Upsilon_{sk}\hat{P}_s}_{\text{Umbrella Pricing}} + \underbrace{\frac{1}{\rho-1}\frac{\Upsilon_{sk}}{\omega_{sk}}\left(\omega_{s\mathcal{C}}-\omega_{sk}\right)\Delta\kappa}_{\text{Cartel Overcharge}} \tag{6}$$

  - $\Upsilon_{sk} := \frac{\omega_{sk}(\rho-1)\left(\frac{1}{\eta}-\frac{1}{\rho}\right)\mu_{sk}}{1+\omega_{sk}(\rho-1)\left(\frac{1}{\eta}-\frac{1}{\rho}\right)\mu_{sk}} \in (0,1)$
  - $\hat{P}_s$: percentage change in the sectoral price index
  - $\Delta\kappa$: change in collusive intensity

Collusion and Productivity

- Change in sectoral productivity:

$$\hat{z}_s = \sum_k \omega_{sk} \left(\frac{\mu_s}{\mu_{sk}} - 1 \right) \hat{P}_{sk} + (\rho - 1) \sum_k \omega_{sk} \frac{\mu_s}{\mu_{sk}} \left(\hat{P}_{sk} - \hat{P}_s \right) \tag{7}$$

  - Direct price effect
  - Market share reallocations: cartel composition matters!

- Aggregate productivity:

$$A = \left[\int_0^1 \left(\frac{\mu_{agg}}{\mu_s} \right)^{\eta} z_s^{\eta - 1} ds \right]^{\frac{1}{\eta - 1}} \tag{8}$$

with

$$z_s = \left[\sum_{k=1}^{K_s} \left(\frac{\mu_s}{\mu_{sk}} \right)^{\rho} z_{sk}^{\rho - 1} \right]^{\frac{1}{\rho - 1}}$$

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Quantification

Parameterization: Cartel Composition

- Cartels: made up of most productive firms
  1. Cartel members are **larger** and more homogeneous than non-members ▸ Evidence
  2. Literature: more productive firms are more likely to find it profitable to join a cartel (Bos and Harrington, 2010, 2015) ▸ Go
  3. Cartel market share typically higher than **70%** (Combe and Monnier, 2012; Zimmerman and Connor, 2015; Harrington et al., 2015)
- Yields reasonable cartel overcharges
  - EU-DG Comp: cartel overcharge of **10%**
  - Overcharges range from 10% to 15% (Laborde, 2019, 2021; Boyer and Kotchoni, 2015)

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Baseline Calibration

Parameter	Interpretation	Value	Method
β	Discount factor	0.96	Assigned
ψ	Labor supply elasticity	0.5	Assigned
δ	Capital depreciation rate	0.1	Assigned
α	Output elasticity of capital	1/3	Assigned
κ	Collusion intensity	0.79	Match data moment
ρ	Substitution within sectors	10.19	Match data moment
η	Substitution between sectors	1.86	Match data moment
ξ	Pareto shape parameter	6.92	Match data moment
σ	Geometric parameter firms	0.003	Match data moment
ζ	Geometric parameter cartel members	0.23	Match data moment

▸ Slope sectoral markups-HHI

Model Fit

▸ Non-Targeted Moments ▸ Markup Distribution ▸ Parameter Identification

Moments	Data	Model	Source
Aggregate markup	1.2	1.2	Literature
Cartel overcharge	10%	10%	Literature
Slope parameter	−0.44	−0.44	Burstein et al. (2020)
Median # firms per sector	237	237	French data
Median # members per cartel	4	4	French data
Panel B: Fraction of firms with relative sales			French data
≤ 0.1	0.306	0.23	
≤ 0.5	0.646	0.716	
≤ 1	0.805	0.844	
≤ 2	0.903	0.921	
≤ 5	0.966	0.968	
≤ 10	0.987	0.985	
≤ 50	0.999	0.998	
≤ 100	1.000	1.000	
Panel C: Fraction of sales in firms with relative sales			French data
≤ 0.1	0.012	0.019	
≤ 0.5	0.098	0.122	
≤ 1	0.185	0.185	
≤ 2	0.288	0.261	
≤ 5	0.435	0.384	
≤ 10	0.543	0.495	
≤ 50	0.793	0.769	
≤ 100	0.867	0.877	

How Costly are Cartels?

Aggregate Gains from Breaking Down Cartels

Calibrated model:	Competitive	Collusion		
Breaking down:		All cartels	Larger cartels	Smaller cartels
	(1)	(2)	(3)	(4)
Panel A: Aggregate productivity gains, %				
$A_{\text{cartel}} \to A_{\text{comp}}$		1.11	0.88	0.23
$A \to A_{\text{eff}}$	2.16	3.67	3.67	3.67
Distance to efficient allocation		−30.34	−24.08	−6.15
Panel B: Aggregate welfare gains				
$\mathcal{M}_{\text{cartel}} \to \mathcal{M}_{\text{comp}}$ (in pp)		−1.54	−1.16	−0.39
$C_{\text{cartel}} \to C_{\text{comp}}$ (in %)		2.52	1.97	0.54
$K_{\text{cartel}} \to K_{\text{comp}}$ (in %)		4.11	3.16	0.93
$Y_{\text{cartel}} \to Y_{\text{comp}}$ (in %)		2.84	2.20	0.62
$L_{\text{cartel}} \to L_{\text{comp}}$ (in %)		0.53	0.40	0.13
$\mathcal{W}_{\text{cartel}} \to \mathcal{W}_{\text{comp}}$ (in %)		2.00	1.56	0.41
$\mathcal{W} \to \mathcal{W}_{\text{eff}}$ (in %)	4.95	7.83		

Aggregate Gains from Decreasing Collusion Intensity

	$\kappa \to 0.1$	$\kappa \to 0.2$	$\kappa \to 0.3$	$\kappa \to 0.4$
	(1)	(2)	(3)	(4)
Panel A: Aggregate productivity gains, in %				
$A_{\text{cartel}} \to A_{\text{comp}}$	0.99	0.85	0.70	0.54
$A_{\text{cartel}} \to A_{\text{eff}}$	3.67	3.67	3.67	3.67
Distance to efficient allocation	−27.10	−23.22	−19.06	−14.83
Panel B: Aggregate welfare gains				
$\mathcal{M}_{\text{cartel}} \to \mathcal{M}_{\text{comp}}$ (in pp)	−1.06	−0.71	−0.46	−0.28
$C_{\text{cartel}} \to C_{\text{comp}}$ (in %)	2.07	1.67	1.3	0.96
$K_{\text{cartel}} \to K_{\text{comp}}$ (in %)	3.16	2.39	1.75	1.23
$Y_{\text{cartel}} \to Y_{\text{comp}}$ (in %)	2.29	1.81	1.39	1.01
$L_{\text{cartel}} \to L_{\text{comp}}$ (in %)	0.36	0.24	0.15	0.09
$\mathcal{W}_{\text{cartel}} \to \mathcal{W}_{\text{comp}}$ (in %)	1.70	1.41	1.12	0.85

Robustness

1. Alternative cartel overcharge target (15%) Robustness
   - Larger κ required $\Longrightarrow$ larger gains from breaking down cartels
2. Alternative aggregate markup targets ($\mathcal{M} = 1.1$ and $\mathcal{M} = 1.3$)
   - Gap between ρ and η still governed by the relationship between HHI and sectoral markups $\Longrightarrow$ small changes
3. Bertrand competition
   - Less markup dispersion $\Longrightarrow$ smaller aggregate productivity gains
4. Heterogeneous κ Robustness
   - $\kappa_{\mathcal{C}} \sim \text{Trunc}\mathcal{N}(\mu, \sigma^2, 0, 1)$ with $\sigma^2 \in \{0.5, 1, 2, 4\}$
   - Productivity gains range from 0.8% to 1.1%; welfare gains range from 1.5% to 2%
   - Larger σ^2, smaller cartel overcharge

Conclusion

Conclusion

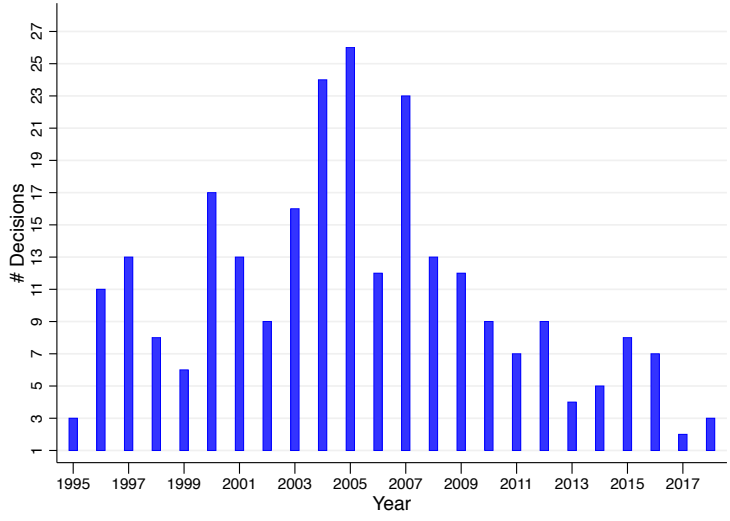
- Cartels: sizeable effects on **aggregate productivity** (-1.1%) and **welfare** (-2%)
- Implications for competition policy:
  - **Complementarity** between competition policies and structural reforms
- Additional remarks:
  - **Static** cost of cartels **high**, dynamic effects unclear
  - Interesting to look at cartels in emerging economies
  - M&As? Collusion along supply chains?

Thank You!

Appendix

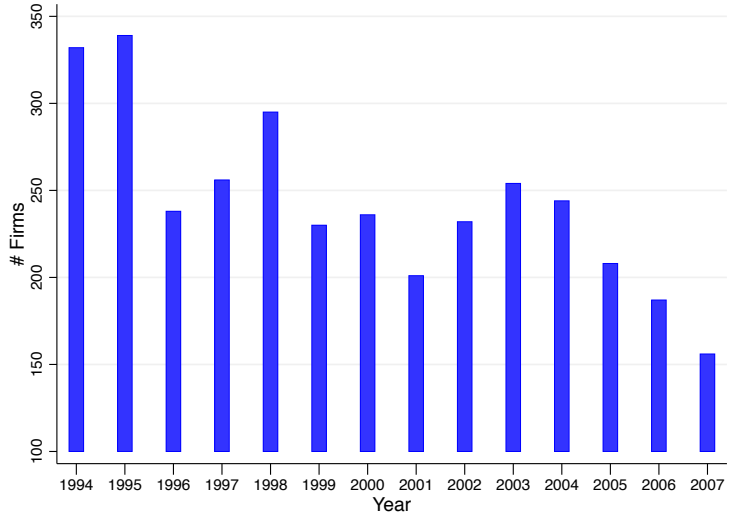
Number of Decisions

Back



Number of Firms involved in Cartels

Back



Institutional Details

1953 **French Technical Commission for Collusions and Dominant Positions** fights against cartels and price fixing

1977 **Competition Commission** advises French Government on any competition-related matters + vertical and horizontal MAs

1986 Companies can directly refer cases to the Council

2001 **New Economic Regulation Law**: leniency programs

2008 **Competition Authority** can review MAs independently from the Minister of Economy and investigate anti-competitive cases on its own

Back

Example of Decision File (17d20): Firms Identity

DÉCISION

Article 1er : Il est établi que les sociétés Tarkett France, Tarkett, Tarkett AB et Tarkett Holding GmbH, Forbo Sarlino, Forbo Participations et Forbo Holding LTD, Gerflor SAS, Midfloor SAS et Topfloor SAS et le syndicat français des enducteurs calandreurs et fabricants de revêtements de sols et murs (SFEC) ont enfreint les dispositions de l'article L. 420-1 du code de commerce et du paragraphe 1 de l'article 101 du traité sur le fonctionnement de l'Union européenne en mettant en œuvre les pratiques visées par les trois griefs exposés au paragraphe 408.

Article 2 : À ce titre, sont infligées les sanctions pécuniaires suivantes :

- à la société Tarkett France, en tant qu'auteur et solidairement avec les sociétés Tarkett, Tarkett AB et Tarkett Holding GmbH, en leur qualité de sociétés mères, une sanction d'un montant de cent soixante-cinq millions d'euros (165 000 000 d'euros) ;

- à la société Forbo Sarlino, en tant qu'auteur et solidairement avec les sociétés Forbo Participations et Forbo Holding LTD, en leur qualité de sociétés mères, une sanction d'un montant de soixante-quinze millions d'euros (75 000 000 d'euros) ;

- à la société Gerflor SAS, en tant qu'auteur et solidairement avec les sociétés Midfloor SAS et Topfloor SAS en leur qualité de sociétés mères, une sanction d'un montant de soixante-deux millions d'euros (62 000 000 d'euros) ;

- au SFEC, en tant qu'auteur, une sanction d'un montant de de trois cent mille euros (300 000 euros).

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Example of Decision File (17d20): Duration and Type of Infringement

430. Ces accords et pratiques concertées constituent, par conséquent, une entente unique, complexe et continue dans le secteur de la fabrication et de la commercialisation des revêtements de sols résilients à laquelle Forbo, Gerflor et Tarkett ont participé, de manière continue, entre le 8 octobre 2001 et le 22 septembre 2011.

(...)

435. Il résulte de ce qui précède, que ces échanges d'informations, mis en œuvre entre 1990 et la fin de l'année 2013, ont été de nature à restreindre la concurrence, en violation du premier paragraphe de l'article 101 du TFUE et de l'article L. 420-1 du code de commerce.

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Cleaning Procedure

1. Drop banking sector (accounting issues + restructuring in 2000's), public administration, domestic services and activities outside France
2. Aggregate some sectors (consistent with I/O Tables and sector-level deflators)
3. Keep firm-year observations
   - With non-negative values of sales, value added, expenditures on materials, capital and at least one employee
   - Drop observations that report non-positive compensations on employees. Capital is constructed using the perpetual inventory method
4. Trim to eliminate outliers
   - Drop when yearly growth rate of total sales is either twice or half its previous year's value

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Cartels by Sector (2007)

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NAF (1)	Sector (2)	Sales Share (3)	VA Share (4)	# Cartels (5)	# Colluding Firms (6)
01-05	Agriculture, hunting, forestry, fishing	0.0010	0.0013		
10-14	Mining and quarrying	0.0029	0.0038		
15-16	Food products, beverages and tobacco	0.0458	0.0419	4	24
17-19	Textiles, leather and footwear	0.0087	0.0093		
20	Wood and wood products	0.0043	0.0046		
21-22	Pulp, paper, publishing and printing	0.0173	0.0194	1	1
23	Coke	0.0209	0.0162		
24	Chemicals	0.0405	0.0378		
25	Rubber and plastics	0.0149	0.0151	2	4
26	Other non-metallic mineral prod.	0.0097	0.0113		
27-28	Basic metals and fabricated metal prod.	0.0341	0.0362	1	2
29	Machinery and equipment n.e.c.	0.0245	0.0259	1	2
30-33	Electrical and optical equipment	0.0270	0.0299		
34-35	Transport equipment	0.0554	0.0383		
36-37	Other manufacturing n.e.c	0.0098	0.0090		
40-41	Electricity, gas and water supply	0.0335	0.0350		
45	Construction	0.0693	0.0866	1	1
50-52	Wholesale and retail	0.3473	0.1930	11	22
55	Hotels and restaurants	0.0213	0.0340		
60-63	Transport and storage	0.0511	0.0617	4	20
64	Post and telecommunications	0.0250	0.0468	1	1
70	Real estate activities	0.0187	0.0315		
71-74	Renting and business activities	0.0861	0.1532	2	7
80	Education	0.0020	0.0039		
85	Health and social work	0.0100	0.0209	1	2
90-93	Other service activities	0.0189	0.0334		

Collusion as Cross-Ownership

- Collusion modeled as common-ownership (O'Brien and Salop, 1999; Azar et al., 2018)
- Owner l's profits with ownership shares of firm j is β_{jl}:

$$\pi^l = \sum_j \beta_{jl} \pi_j$$

- Managers of k maximize weighted average of k's shareholders' portfolios:

$$\tilde{\pi}_k = \sum_l \gamma_{lk} \pi^l = \sum_l \gamma_{kl} \sum_j \beta_{jl} \pi_j \tag{9}$$

  - γ_{lj}: degree of control of l over j

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Proof of Proposition 1

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In equilibrium, with a symmetric cartel, changes in price are:

- Non-cartel firms

$$\hat{P}_{sk} = \Upsilon_{sk}\hat{P}_s \tag{10}$$

- Cartel firms

$$\hat{P}_{sk} = \Upsilon_{sk}\hat{P}_s + \frac{\Upsilon_{sk}}{\omega_{sk}}\frac{1}{\rho - 1}\left(\omega_{s\mathcal{C}} - \omega_{sk}\right)\Delta\kappa \tag{11}$$

- Price level

$$\hat{P}_s = \frac{1}{\rho - 1}\frac{1}{1 - \sum_k \omega_{sk}\Upsilon_{sk}}\sum_{k\in\mathcal{C}}\Upsilon_{sk}\left(\omega_{s\mathcal{C}} - \omega_{sk}\right)\Delta\kappa \tag{12}$$

  - $0 < \Upsilon_{sk} < 1$ and increasing with ω_{sk}

Cartel Members are Typically Large Firms

	Cartel Members				Competitive Firms			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Market Share (%)	3.43	10.79	0	100	0.07	0.92	0	100
Sales (€m)	295	1851	0.01	36,700	2	56	0	45,600
Value-added (€m)	119	988	0	18,400	0.6	14	0	9927
ln Labor Productivity	3.87	0.65	0.097	8.36	3.49	0.64	−2.8	9.52
Labor	1,402	13,014	1	295,030	12	156	1	86,587
ln Wage	3.6	0.4	0.61	7.45	3.2	0.6	−2.4	8.6
ln Capital/Labor ratio	2.25	1.25	−2.04	6.47	1.71	1.24	−2.16	10.3
Intermediates (€m)	181	1055	0	28,900	1.5	45.9	0	39,800
# Obs.			10,721				12,441,919	
# Firms			907				2,167,168	
# Exporters			613				232,316	

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Cartel Screen and Cartel Formation

1. Model delivers a cartel screen

$$\frac{1}{\mu_{sk}^{\mathcal{C}}} = \frac{\rho - 1}{\rho} - \left(\frac{1}{\eta} - \frac{1}{\rho}\right)(1 - \kappa)\omega_{sk} - \left(\frac{1}{\eta} - \frac{1}{\rho}\right)\kappa \sum_{j \in \mathcal{C}} \omega_{sj} \tag{13}$$

   - Estimate $\kappa = 0.7$, close to our benchmark value $\kappa = 0.79$! Estimation
   - Caveat: no price data (Bond et al., 2021; De Ridder et al., 2022)

2. Abstract from endogenous cartel formation but:

   - Aggregate profit gains for some cartels (even when κ is high) Distribution

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Anticompetitive Firm Premium

	ln Sales			Market Share			ln Employment			ln Labor Productivity		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Panel A: All cartels												
$\mathbb{1}_{\text{Collude}}$	4.040***	3.582***	3.002***	4.400***	4.297***	4.028***	3.306***	2.998***	2.526***	0.478***	0.364***	0.318***
	(0.092)	(0.092)	(0.082)	(0.548)	(0.542)	(0.473)	(0.084)	(0.084)	(0.075)	(0.027)	(0.024)	(0.022)
# Obs.	12,452,544	12,452,544	12,452,544	12,452,544	12,452,544	12,452,544	12,452,544	12,452,544	12,452,544	12,452,544	12,452,544	12,452,544
R^2	0.002	0.177	0.315	0.005	0.036	0.198	0.002	0.096	0.215	0.000	0.091	0.152
Panel B: Price-fixing cartels												
$\mathbb{1}_{\text{Collude}}$	3.912***	3.268***	2.881***	2.923***	2.822***	2.720***	2.940***	2.546***	2.301***	0.575***	0.445***	0.364***
	(0.149)	(0.140)	(0.124)	(0.397)	(0.391)	(0.375)	(0.131)	(0.122)	(0.110)	(0.037)	(0.033)	(0.033)
# Obs.	12,450,922	12,450,922	12,450,922	12,450,922	12,450,922	12,450,922	12,450,922	12,450,922	12,450,922	12,450,922	12,450,922	12,450,922
R^2	0.000	0.176	0.315	0.000	0.033	0.199	0.000	0.095	0.215	0.000	0.091	0.151
Two-digit Sector × Year FE	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes	No
Four-digit Industry × Year FE	No	No	Yes	No	No	Yes	No	No	Yes	No	No	Yes

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Anticompetitive Firms and Firm Rank

	Dummy Anticompetitive Firm					
	(1)	(2)	(3)	(4)	(5)	(6)
ln Rank Market Share	-0.0003***	-0.0003***	-0.0005***			
	(0.0000)	(0.0000)	(0.0000)			
$\mathbb{1}_{\text{Top 4 Industry}}$				0.0163***	0.0163***	0.0164***
				(0.0015)	(0.0015)	(0.0015)
2-Digit Sector × Year FE	No	Yes	No	No	Yes	No
4-Digit Industry × Year FE	No	No	Yes	No	No	Yes
# Observations	12,452,544	12,452,544	12,452,544	12,452,544	12,452,544	12,452,544
R-sq.	0.0012	0.0021	0.0186	0.0036	0.0045	0.0209

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Labor Productivity and Sales Dispersion: Non-Cartel versus Cartel Members

Moment	Non-Cartel Members			Cartel Members		
	Mean (1)	Std. Dev. (2)	IQ Range (3)	Mean (4)	Std. Dev. (5)	IQ Range (6)
Panel A: Labor productivity						
Median	3.765	0.450	0.482	4.474	0.935	1.133
IQ range	0.722	0.316	0.250	0.389	0.347	0.666
90-10 percentile range	1.463	0.550	0.503	0.531	0.527	0.861
95-5 percentile range	1.971	0.699	0.675	0.572	0.540	0.945
Panel B: Sales						
Median	6.623	1.264	1.56	10.845	2.347	2.311
IQ range	1.989	0.835	0.821	1.197	1.149	1.788
90-10 percentile range	3.774	1.394	1.551	1.562	1.371	2.422
95-5 percentile range	4.828	1.700	1.995	1.625	1.416	2.839

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Dispersion within the Manufacture of Plastic Components for Construction

	Labor Productivity		Log Sales	
	Non-Cartel Members (1)	Cartel Members (2)	Non-Cartel Members (3)	Cartel Members (4)
Median	4.758	5.585	7.695	10.516
IQ range	0.497	0.183	2.140	1.116
90-10 percentile range	0.984	0.183	4.135	1.116
95-5 percentile range	1.404	0.183	5.107	1.116

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IO Literature

- **Empirics: Cumulative Market Share (CMS) of cartel members is very large**
  - Combes and Monnier (2012): average CMS of 48 European cartels is 80% (two-thirds have a CMS $> 75\%$)
  - Zimmerman and Connor (2005): average CMS is 85% for private international cartels
  - Harrington et al. (2015): German cement cartel (6 firms) had a CMS of 86% in 2005
- **Theory: larger firms are more likely to find it profitable to join a cartel**
  - Trade-off between changes in markups and sales: "we should not expect a cartel to include very small firms" (Bos and Harrington, 2010)

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Sectoral Markup and Concentration

- Sectoral markups in non-cartelized sectors:

$$\mu_s^{-1} = \frac{\rho - 1}{\rho} - \frac{\frac{\rho}{\eta} - 1}{\rho} \underbrace{\text{HHI}_s}_{:=\sum_{k=1}^{K_s} \omega_{sk}^2} \tag{14}$$

- Burstein et al. (2020) estimate:

$$\mu_s^{-1} = \underbrace{\alpha}_{:=\frac{\rho-1}{\rho}} + \underbrace{\beta}_{:=\frac{\frac{\rho}{\eta}-1}{\rho}} \text{HHI}_s + \epsilon_{st} \tag{15}$$

- Sectoral markups in cartelized sectors:

$$\mu_s^{-1} = \frac{\rho - 1}{\rho} - \frac{\frac{\rho}{\eta} - 1}{\rho} \left(\text{HHI}_s + \kappa \sum_{j \in \mathcal{C} \setminus \{k\}} \omega_{sj} \omega_{s\mathcal{C}} \right) \tag{16}$$

- Target: $\hat{\beta} = -0.44$ for non-cartelized sectors (Burstein et al., 2020)

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Non-Targeted Moments

Moments	Data	Model	Source
Cartel premium (sales)	4.040	3.214	French data
Cartel premium (employment)	3.306	3.006	French data
Cartel premium (labor productivity)	0.478	0.208	French data
Cartel premium (market share)	4.400	5.750	French data
Standard deviation of log sales	1.391	1.366	French data
Standard deviation of log employment	1.165	1.354	French data

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Markup Distribution

	Unconditional markup distribution		Sectoral markup distribution	
	Benchmark (1)	Competitive economy (2)	Benchmark (3)	Competitive economy (4)
p50	1.109	1.109	1.173	1.160
p75	1.110	1.109	1.215	1.198
p90	1.112	1.111	1.292	1.262
p95	1.116	1.115	1.381	1.334
p99	1.262	1.148	1.727	1.552
SD log	0.023	0.011	0.078	0.069
log p95/p50	0.006	0.005	0.163	0.140

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Distribution of Cartel Members' Markups

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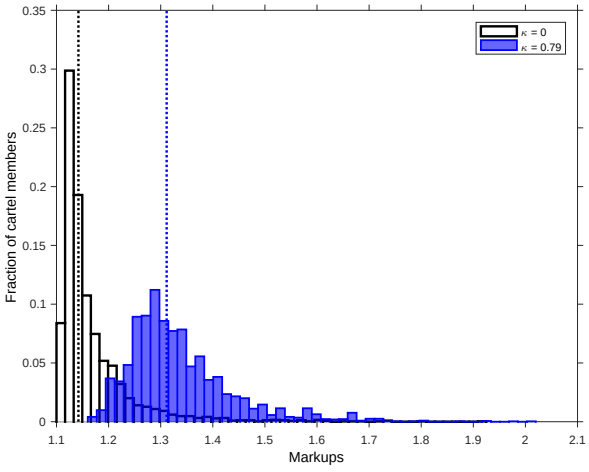
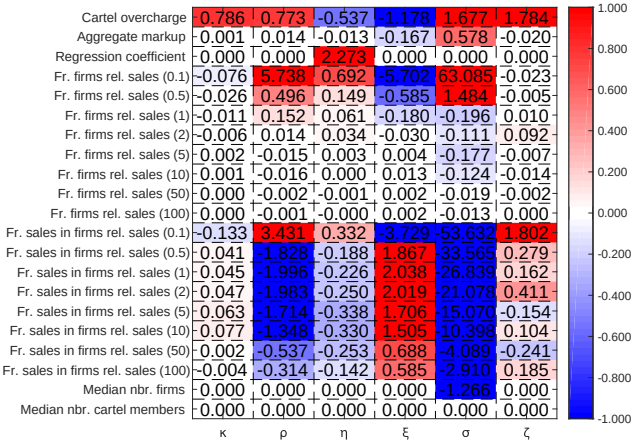


Parameter Identification



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Umbrella Pricing Effects are Small

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	Benchmark	No umbrella pricing effect
	(1)	(2)
Panel A: Aggregate productivity gains, in %		
$A_{\text{cartel}} \to A_{\text{comp}}$	1.11	1.14
$A \to A_{\text{eff}}$	3.67	3.67
Distance to efficient allocation	−30.34	−30.98
Panel B: Aggregate welfare gains		
$\mathcal{M}_{\text{cartel}} \to \mathcal{M}_{\text{comp}}$ (in pp)	−1.54	−1.44
$C_{\text{cartel}} \to C_{\text{comp}}$ (in %)	2.52	2.50
$K_{\text{cartel}} \to K_{\text{comp}}$ (in %)	4.11	3.99
$Y_{\text{cartel}} \to Y_{\text{comp}}$ (in %)	2.84	2.80
$L_{\text{cartel}} \to L_{\text{comp}}$ (in %)	0.53	0.49
$\mathcal{W}_{\text{cartel}} \to \mathcal{W}_{\text{comp}}$ (in %)	2.00	2.01

Estimating the Collusion Intensity Parameter κ

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- Model's equilibrium inverse markups:

$$\frac{1}{\mu_{sk}^{\mathcal{C}}} = \frac{\rho - 1}{\rho} - \left(\frac{1}{\eta} - \frac{1}{\rho}\right)(1 - \kappa)\omega_{sk} - \left(\frac{1}{\eta} - \frac{1}{\rho}\right)\kappa \sum_{j \in \mathcal{C}} \omega_{sj}$$

- Regress firm-level labor shares on market shares:

$$\underbrace{\frac{W\ell_{sk}}{p_{sk}q_{sk}}}_{\text{Labor share}} = a_0 + a_1\omega_{sk} + a_2 \sum_{j \in \mathcal{C}} \omega_{sj} + \nu_{sk}$$

- Collusion intensity κ is recovered from the estimated parameters:

$$\hat{\kappa} = \frac{\hat{a}_2}{\hat{a}_1 + \hat{a}_2} \tag{17}$$

Estimation of κ

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Sample	Inverse Markup					
	All cartels			Price-fixing cartels		
	(1)	(2)	(3)	(4)	(5)	(6)
Firm's Market Share	-0.531***	-0.140	-0.130	-0.682***	0.149	0.1598
	(0.176)	(0.188)	(0.190)	(0.188)	(0.325)	(0.325)
Cartel's Market Share		-0.320***	-0.326***		-0.320***	-0.496***
		(0.052)	(0.051)		(0.162)	(0.163)
Intercept	0.704***	0.729***	0.729***	0.684***	0.706***	0.705***
	(0.009)	(0.008)	(0.008)	(0.013)	(0.014)	(0.014)
Implied κ		0.70	0.71		1.42	1.48
Sum Coefficients		-0.46	-0.46		-0.35	-0.34
Ratio Coefficients		-0.63	-0.63		-0.50	-0.48
Year FE	No	No	Yes	No	No	Yes
# Observations	2,235	2,235	2,235	931	931	931
R-sq.	0.0575	0.1057	0.1147	0.0476	0.0939	0.1022

Profit Incentives to Collude

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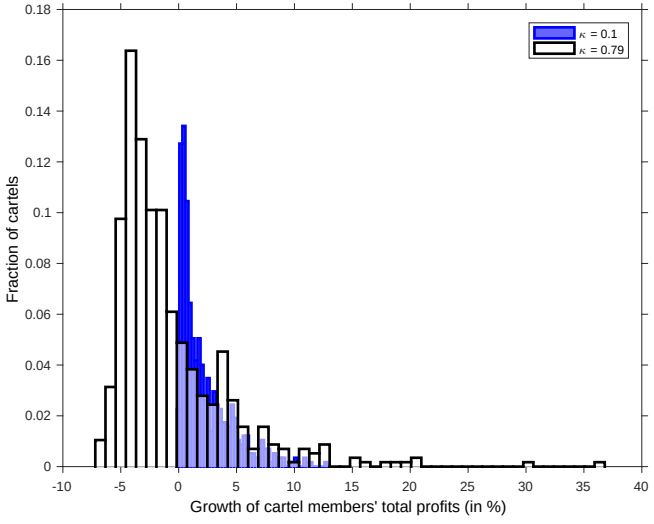

Alternative Targets and Mode of Competition

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	Overcharge 15%	$\mathcal{M} = 1.1$	$\mathcal{M} = 1.3$	Bertrand
	(1)	(2)	(3)	(4)
$A_{\text{cartel}} \to A_{\text{comp}}$	1.63	1.37	0.90	0.55
$A_{\text{cartel}} \to A_{\text{eff}}$	4.19	3.71	3.74	1.40
Distance to efficient allocation	−38.85	−36.91	−23.98	−39.17
$\mathcal{M}_{\text{cartel}} \to \mathcal{M}_{\text{comp}}$ (in pp)	−1.50	−0.43	−2.34	−2.25
$C_{\text{cartel}} \to C_{\text{comp}}$ (in %)	3.31	2.30	2.61	2.07
$K_{\text{cartel}} \to K_{\text{comp}}$ (in %)	4.90	2.79	4.88	4.38
$Y_{\text{cartel}} \to Y_{\text{comp}}$ (in %)	3.62	2.41	3.03	2.53
$L_{\text{cartel}} \to L_{\text{comp}}$ (in %)	0.53	0.16	0.76	0.77
$\mathcal{W}_{\text{cartel}} \to \mathcal{W}_{\text{comp}}$ (in %)	2.77	2.07	1.96	1.35

Heterogeneous κ

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	Het. κ $\sigma^2_{\mathcal{N}} = 0.5$ (5)	Het. κ $\sigma^2_{\mathcal{N}} = 1$ (6)	Het. κ $\sigma^2_{\mathcal{N}} = 2$ (7)	Het. κ $\sigma^2_{\mathcal{N}} = 4$ (8)
$A_{\text{cartel}} \to A_{\text{comp}}$	1.10	1.11	0.95	0.84
$A_{\text{cartel}} \to A_{\text{eff}}$	3.66	3.67	3.71	3.52
Distance to efficient allocation	−30.17	−30.28	−25.60	−23.78
$\mathcal{M}_{\text{cartel}} \to \mathcal{M}_{\text{comp}}$ (in pp)	−1.40	−1.53	−1.33	−1.26
$C_{\text{cartel}} \to C_{\text{comp}}$ (in %)	2.45	2.50	2.16	1.98
$K_{\text{cartel}} \to K_{\text{comp}}$ (in %)	3.92	4.05	3.54	3.35
$Y_{\text{cartel}} \to Y_{\text{comp}}$ (in %)	2.74	2.81	2.43	2.25
$L_{\text{cartel}} \to L_{\text{comp}}$ (in %)	0.49	0.52	0.46	0.46
$\mathcal{W}_{\text{cartel}} \to \mathcal{W}_{\text{comp}}$ (in %)	1.96	1.99	1.71	1.53
P25 κ	0.78	0.61	0.36	0.29
Median κ	0.89	0.80	0.62	0.55
P75 κ	0.95	0.91	0.82	0.78