COOPERATION AS A PRICE STABILIZING MECHANISM IN MINERAL MARKETS

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Purpose

- Extreme variability of prices
- Previous Price stabilizing mechanisms:
  - Buffer stocks (UNCTAD's IPC)
  - Quota agreements
  - Fixing prices
- Prisoner's Dilemma and cooperation
- Alternative Price stabilizing mechanism:
  - Cooperation among a few large producers
- Advantage: Stability of policies (the stabilization is an outcome of a profit maximization objective)
- Welfare-enhancing cooperation

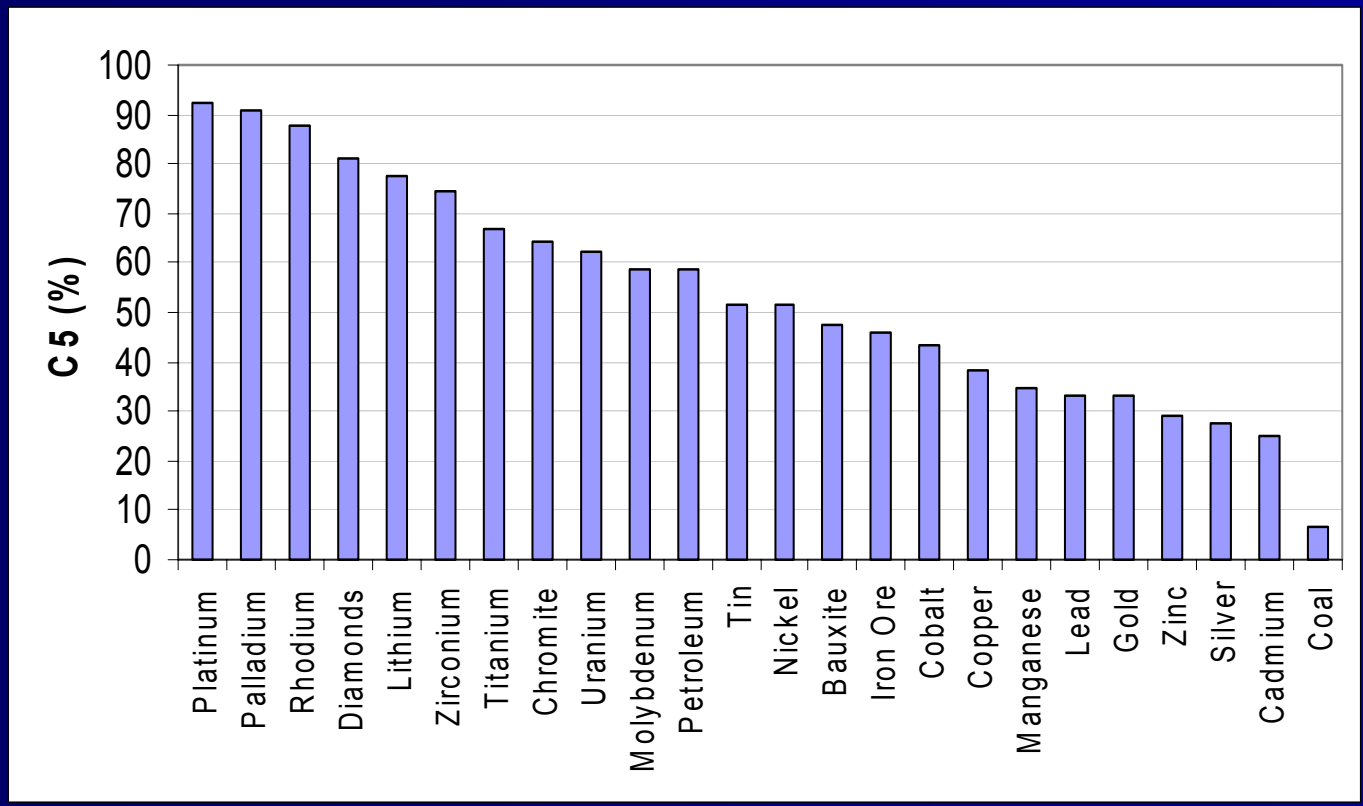
Literature Review

- Commodity price stabilization models:
  - Labys, W. (1980)
  - Anderson, W. and Gilbert, C. (1988)
  - Tilton, J. E. (1992)
- Producer Collusion:
  - Van Duyne, C. (1975)
  - Pindyck, R. (1979)
  - Salant, S.W. (1976)

Welfare-enhancing collusion

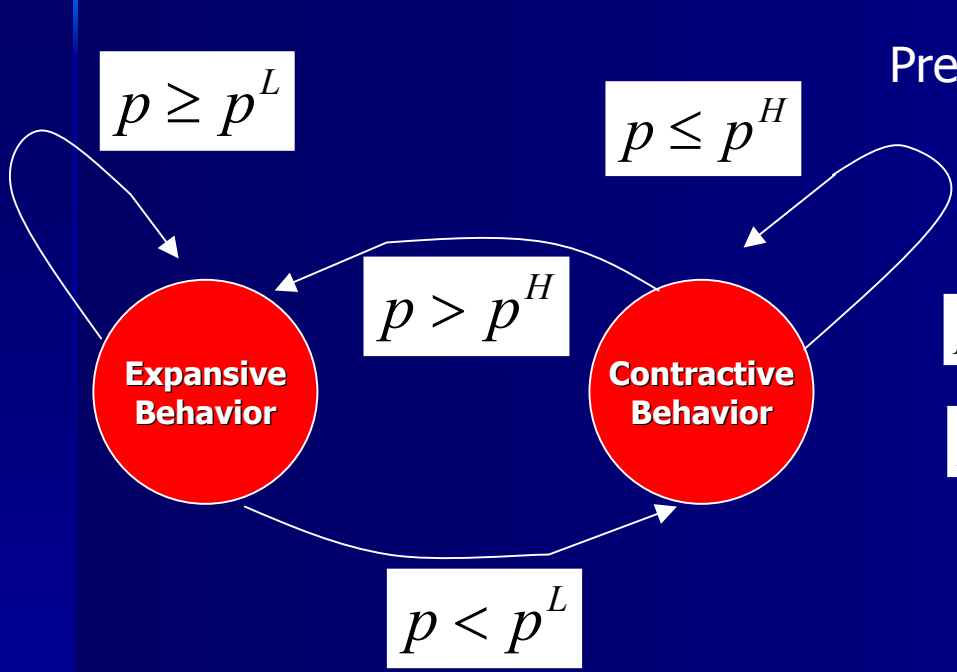
- Montero, J.-P. and Guzmán, J.I. (2005)
- few large firms (or *strategic firms*), and a large amount of small and non- influential firms
- They showed that cooperation in periods of booms is not determined by production cutbacks of large firms, but by expansion.
- Then cooperation could be used as a price stabilizing mechanism
- Cooperation vs Collusion

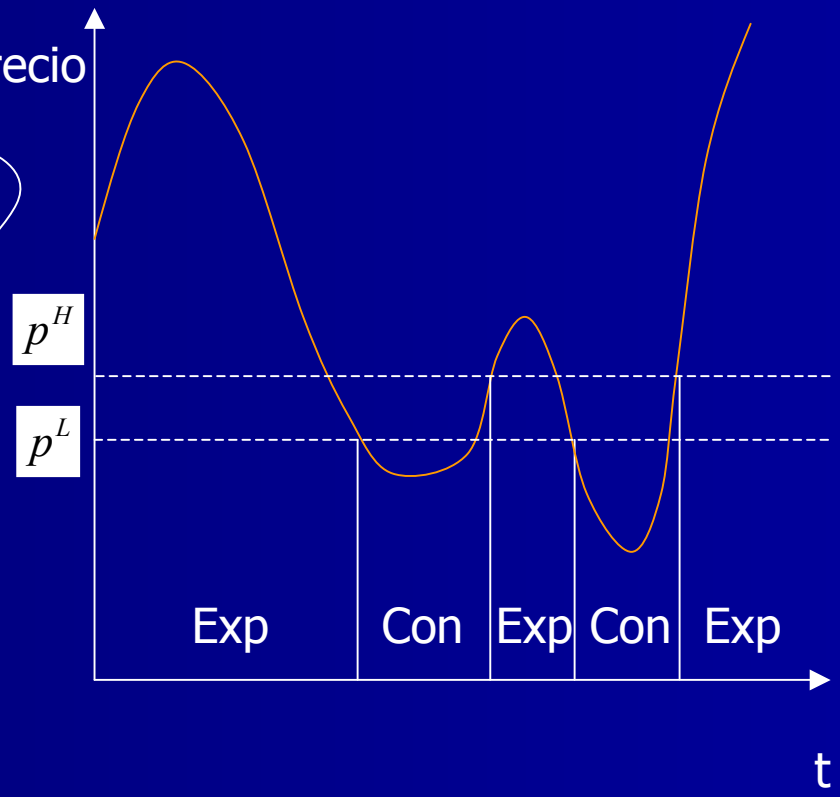
Concentration Index for selected mineral industries 2003



Guzmán (2006)

Modeling the Trigger Prices





Mathematical derivation of Trigger Prices

$$V = \pi^C + \delta \Pr\left\{\theta P^C(Q,\chi) \le P^H\right\} V + \delta \Pr\left\{\theta P^C(Q,\chi) > P^H\right\} W$$

$$W = \pi^E + \delta \Pr\left\{\theta P^E(Q,\chi) \le P^L\right\} V + \delta \Pr\left\{\theta P^E(Q,\chi) > P^L\right\} W$$

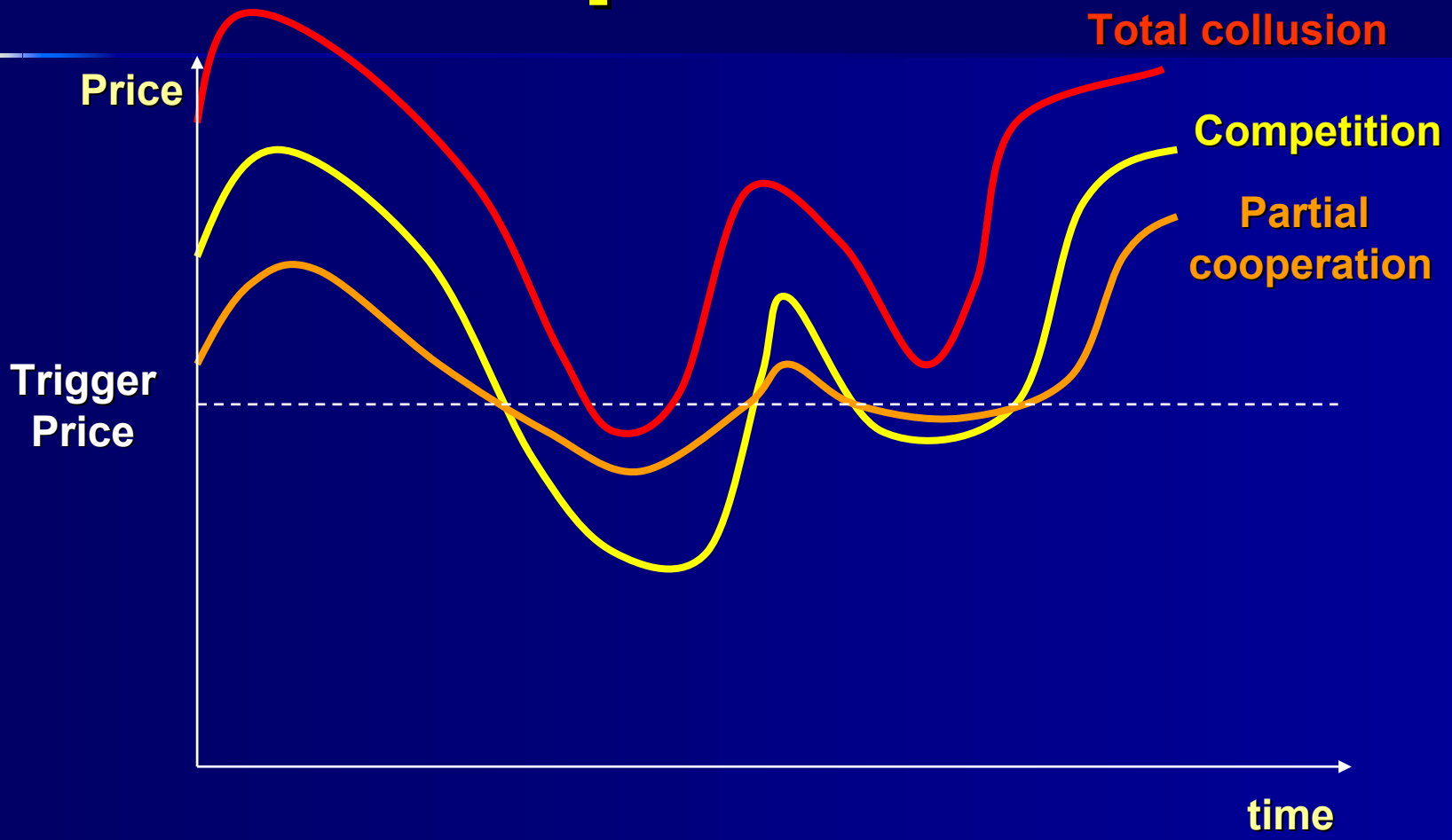
$$V = \frac{\left(1-\delta\left[1-F\left(P^L/P^E\right)\right]\right)\pi^C + \delta\left[1-F\left(P^H/P^C\right)\right]\pi^E}{(1-\delta)\left[1+\delta\left(F\left(P^L/P^E\right)-F\left(P^H/P^C\right)\right)\right]}$$

$$W = \frac{\delta F\left(P^L/P^E\right)\pi^C + \left(1-\delta F\left(P^H/P^C\right)\right)\pi^E}{(1-\delta)\left[1+\delta\left(F\left(P^L/P^E\right)-F\left(P^H/P^C\right)\right)\right]}$$

$$\frac{\partial V}{\partial P^H} = 0$$

$$\frac{\partial W}{\partial P^L} = 0$$

Cooperation effect on price



Empirical Application

International Copper Cartel
1935-1939

Cartel members

- Full members:
  - Rhokana Corporation (UK)
  - Mufulira Copper Mines Ltd. (UK)
  - Union Minière du Haut Katanga (Belgium)
  - Braden Copper Company, (Chile)
  - Anaconda (Chile and Mexico)
- "Friendly" members:
  - Compagnie du Mines de Bor (Yugoslavia)
  - Rio Tinto Company (Spain)
- Competitive fringe (approx. 50%)

International Copper Cartel 1935-1939

Period	Quota status	Cartel production: Production (Annual rate)	Cartel production: Per cent change from preceding period	Noncartel production: Production (Annual rate)	Noncartel production: Per cent change from preceding period	London spot price: Cents per pound	London spot price: Per cent change from preceding period
July-Dec. 1935	Quotas	559		408		8.2	
Jan.-Dec. 1936	Quotas	598	+7.0%	368	-9.8%	9.5	+16%
Jan.-Nov. 1937	No Quotas	917	+53.4%	439	+19.3%	13.4	+41%
Dec.1937-Sep. 1938	Quotas	762	-16.9%	481	+9.6%	9.7	-28%
Oct. 1938-Dec. 1938	No Quotas	948	+24.4%	504	+4.8%	10.6	+9%
Jan. 1939-July 1939	Quotas	736	-22.4%	511	+1.4%	10	-6%

(Production figures are converted to annual rates, thousands of short tons)

(Source: O. Herfindahl, 1959)

COPPER CARTEL LIFTS LIMIT ON PRODUCTION
New York Times (1857-Current file); Oct 11, 1938; ProQuest Historical Newspapers The Ne
pg. 37

COPPER CARTEL LIFTS LIMIT ON PRODUCTION

Output Will Be Pushed Up to 105% of Basic Tonnage

The international copper cartel announced in London yesterday that, effective on Oct. 15, production will be increased to 105 per cent of agreed basic tonnages. It is expected that this will result in an increase of an additional 6,000 tons a month. It will bring production back to the level of July 1, when the output was reduced from 105 per cent of basic tonnages to 95 per cent.

Numerical simulation

Cartel Price

Competitive Price

Table 2. Collusive and non-collusive equilibria for the copper cartel of 1935-39

t	θ	c_s	c_f	Q_s^m	Q_f^m	P^m	Q_s^{nc}	Q_f^{nc}	P^{nc}
1	0.23	2.19	2.00	46.6	34.0	8.2	56.6	28.1	7.6
2	0.27	2.31	2.41	49.8	30.7	9.5	61.6	24.2	8.6
3	1.00	1.44	3.16	76.4	36.6	13.4	70.6	41.5	14.0
4	0.49	1.75	2.22	63.5	40.1	9.7	66.5	38.1	9.5
5	1.36	1.12	2.38	79.0	42.0	10.6	52.0	66.7	12.8
6	0.51	2.02	2.22	61.3	42.6	10.0	61.9	42.3	9.9

Note: a = 92.5.

International Copper Cartel effect over the price

- Mean price with-cartel: 10.4 USc/lb
- Mean price without-cartel: 10.3 USc/lb
- σ with-cartel: 1.73 USc/lb
- σ without-cartel: 2.31 USc/lb

- As a summary, the mean price with or without the cartel is similar, but with the cartel the price volatility reduces around 34% with respect to the non-cartel market equilibrium.

Econometric Model

- Monthly information, between July 1935 to July 1939
- MS_t cartel's market share of the world's production
- P_t Average monthly LME spot price
- D_t Dummy variable. Equal to 1 if the price is higher than 10 cents a pound and 0 if it is not
- $\lambda_t = MS_t / (1 - MS_t)$ Ratio of the cartel's production levels to Competitive Fringe
- ACP_t periods in which the cartel is under a quota status

Econometric evidence

- Unrestricted log-linear model

$$Ln(\lambda_t) = \alpha_0 + \alpha_1 Ln(P_t)(1 - D_t) + \alpha_2 Ln(P_t) D_t + \alpha_3 ACP_{t-1} + \alpha_4 Ln(\lambda_{t-1}) + \varepsilon_t$$

- Restricted log-linear model

$$Ln(\lambda_t) = \beta_0 + \beta_1 Ln(P_t) + \beta_2 ACP_{t-1} + \beta_3 Ln(\lambda_{t-1}) + \varepsilon_t$$

OLS estimation

	Unrestricted Model	Restricted Model
α_0, β_0		
Coefficient	-0.3750	-1.0041
Std. Error	0.3815	0.2947
β_1		
Coefficient	-	0.5363
Std. Error	-	0.1447
α_1		
Coefficient	0.2493	-
Std. Error	0.1813	-
α_2		
Coefficient	0.3061	-
Std. Error	0.1670	-
α_3, β_2		
Coefficient	0.0077	0.0056
Std. Error	0.0031	0.0031
α_4, β_3		
Coefficient	0.4286	0.4532
Std. Error	0.1257	0.1321
Adjusted R-squared	0.70	0.67
Durbin-Watson statistic	2.03	2.06
Schwarz criterion	-1.44	-1.40

Implications and future research

- This cooperative strategy bears a higher price stability which finally redounds in benefits not only for producers and consumers, but also for countries whose economies strongly depend on these minerals.
- These cooperation policies only affect the actors belonging to the inefficient competitive fringe in a direct way, so cooperation among strategic firms also seems to act as a self-regulating structure that delimits the entrance of inefficient mines into the industry during periods of prosperity.
- One disadvantage of this type of partial cooperation in mineral markets is that during recessions it is technically simpler to cut output (either through physical production or through holder stocks) than to increase it during booms.
- To test the theoretical output expansion during booms, other interesting examples for future research are the Coal, the Iron and Steel Cartels that operated in Germany between 1893 and 1914.