

On the misuse of regressions of price on the HHI in merger review

Nathan Miller et al
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Presented by: Ka Yan CHENG

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Motivation

Role of HHI on merger review

The Herfindahl-Hirschman Index (HHI) measures market concentration by taking the form of:

$$HHI = 10000 \times \sum_n s_n^2$$

where $s_j = \frac{q_j}{Q}$ indicates the market share of each firm i .

For example, for a market with 3 firms that own output shares of 40%, 30% and 30%:

$$HHI = 40^2 + 30^2 + 30^2 = 3400$$

HHI = 0: Perfect competition

HHI = 10000: Monopoly market

Motivation

Role of HHI on merger review

Connecting HHI with merger

- All else equal, decrease in number of firms leads to a higher HHI
- Given same amount of firms, HHI increases when the market share of larger firms increase
- The implied change in HHI after merger of firm i and k :

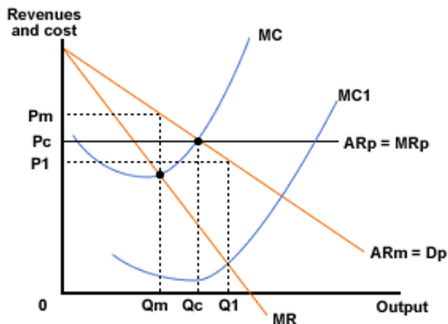
$$\Delta HHI = 2 \times s_i \times s_k$$

Motivation

Role of HHI on merger review

Merger review

- Goal: identify and prevent mergers that are more likely to have anticompetitive effects (raise price, reduce output)



[Source of figure]

- Question of interest:
Causal impact of **mergers** on price

Motivation

Relationship between price and HHI

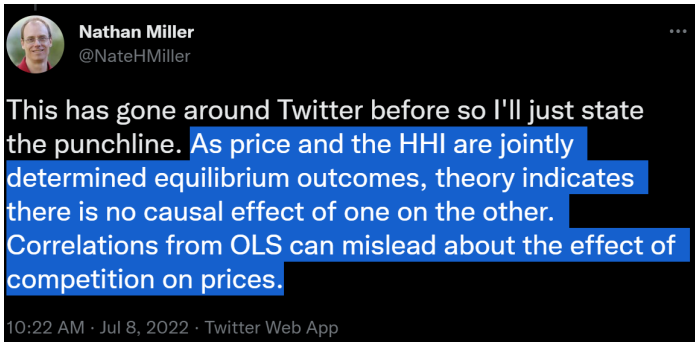
HHI on merger review in practice

- 1 The Horizontal Merger Guidelines of the US Department of Justice and Federal Trade Commission (2010)
 - Mergers that generate a **post-merger HHI above 2500** and **increase in the HHI by 200 or more** "will be presumed to be likely to enhance market power"
- 2 Courts in the state
- 3 Merger guidelines of the European Union

Causal impact of **mergers** on price
v.s.
Causal impact of **HHI** on price

To explain why regressions of price on the HHI should **NOT** be used in merger review

Preview of findings



Provide simple numerical examples to demonstrate

- ① Empirical price-HHI relationship is not useful for telling the competitive effects of mergers in general
- ② The exceptional case that the former statement would not be true

More like a guidebook, no data has been used.

Results

Numerical example of misleading price-HHI comparison

Why it might not work well?

Setup of the numerical example: (Cournot competition model)

Let the market inverse demand be $P(Q) = 10 - Q$, and let there be $n = 1, 2, \dots, N$ firms. In the equilibrium, the output of firm i is given by

$$q_i = \frac{10 - c_i + N(\bar{c} - c_i)}{(N + 1)}$$

where c_i is the marginal cost of firm i and $\bar{c} = \frac{1}{N} \sum_N c_n$ is the average marginal cost. The equilibrium price is

$$P = \frac{10 + N\bar{c}}{N + 1}$$

And the equilibrium market quantity is

$$Q = \sum_n q_n = \frac{N(10 - \bar{c})}{(N + 1)}$$

Numerical example of misleading price-HHI comparison

Why it might not work well?

Consider $N = 2$ firms that produce a homogenous good in 3 different regions which they have different marginal costs in production:

Table 1. The price-HHI relationship with cost variation

	Region A	Region B	Region C	Monopoly
Firm 1's costs	3.00	4.00	1.83	3.00
Firm 2's costs	3.00	3.00	3.00	
Firm 1's share (%)	50	38	62	100
Firm 2's share (%)	50	62	38	
Market price	5.33	5.67	4.94	6.50
Quantity	4.67	4.33	5.06	3.50
HHI	5000	5288	5288	10,000

Comparing columns 1,2,3 with column 4 one by one, we can see the correlation between price and the HHI is ambiguous.

Regressions of price on the HHI

What is the problem?

Typical form of a price on HHI regression model:

$$P_i = \beta_0 + \beta_1 \text{HHI}_i + \beta_2 x_i + \epsilon_i$$

Again, our numerical example:

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HHI	5000	5288	5288	10,000

If we run a regression of price on the HHI based on the data of all 3 regions, we will get a slightly negative relationship.

Regressions of price on the HHI

What is the problem?

The problem:

- 1 Both price and the HHI are market equilibrium outcomes. They are jointly determined in the equilibrium and there is no causal effect of one on the other.
- 2 Different estimate of the regression coefficient can pick up various possible correlations that exist due to variation in the underlying demand and supply factors, but **CANNOT** measure a causal effect that **DOES NOT** exist.

Appropriate role of the HHI in merger review

How should we use it?

A special case:

Empirical variation in the HHI is driven predominantly by changes in competition

Appropriate role of the HHI in merger review

How should we use it?

Now consider constant marginal cost $c = 3$ for all firms, and consider markets with different number of competitors:

Table 2. Merger price effects and the implied HHI change

	Number of pre-merger competitors				
	Two	Three	Four	Five	Six
Percentage price increase	21.88	12.28	7.95	5.60	4.17
Percentage quantity decrease	25.00	11.11	6.25	4.00	2.78
Implied change in the HHI	5000	2222	1250	800	556

Relationship between the HHI and the price is still not causal, but the correlation in such special case can at least provide information on the impact of a merger on price.

But in such case, just analyse directly the impact on prices from the merger event instead of the one that has been mediated through the HHI.

What would be other better ways to empirically quantify the causal impact of **mergers** on price/output level?

Regression of price on the HHI does not provide useful information on antitrust review of mergers as there is **NO** causal relationship between the two.