The First-Order Approach to Merger Analysis

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Background

Recently there has been a lot of work in what we refer to as "the first-order approach to merger analysis" (FOAM)

- Werden (1996): uses only information local to the pre-merger equilibrium to calculate the hypothetical efficiency gains necessary to offset the pressure to increase prices
- Farrell and Shapiro (2010): develop *Upward Pricing Pressure* (UPP) that uses pre-merger information and efficiency credits to predict whether a merger will increase prices
- Implemented by Davis (in UK) and Farrell and Shapiro (in US)

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   - allow for non-pricing conduct and non-Nash equilibrium
   - generalize the diversion ratio
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$$\Delta CS \approx -\underbrace{g^{\mathrm{T}}}_{\text{GePP}} \cdot \underbrace{\rho}_{\text{merger pass-through}} \cdot \underbrace{Q}_{\text{quantity}}$$

The General Model

An industry with multi-product firms and generic strategies

- Each firm $i = 1, \ldots, n$ has m_i products
- It chooses strategies $\sigma_i = (\sigma_{i1}, \ldots, \sigma_{im_i})$
- It has quantity and price vectors: Q_i and P_i
- Its profit function is:

$$\pi_i = P_i(\sigma)^{\mathrm{T}} Q_i(P(\sigma)) - C_i(Q_i(P(\sigma))),$$

- Firms can *conjecture* other firms' reactions to changes in their strategies
  - We denote the total derivative $\frac{dA}{d\sigma_i} \equiv \frac{\partial A}{\partial \sigma_i} + \left(\frac{\partial A}{\partial \sigma_{-i}}\right)^{\mathrm{T}} \frac{\partial \sigma_{-i}}{\partial \sigma_i}$

Prices as Strategies

Comparison to UPP and estimation of price changes are easier if we think of firms as setting prices

- As long as the map from strategies to prices is invertible, this is without loss of generality
- Other firms' non-price setting behavior is incorporated into the conjectures concerning their reactions
    - Cournot can be reformulated as a firm setting prices and conjecturing that other firms will adjust their prices to keep their quantities fixed
    - Again, the total derivative is $\frac{dQ}{dP_i} \equiv \frac{\partial Q}{\partial P_i} + \left(\frac{\partial Q}{\partial P_{-i}}\right)^{\mathrm{T}} \frac{\partial P_{-i}}{\partial P_i}$

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The pre-merger first-order condition simplifies to:

$$f_i^{\sigma}(\sigma) \equiv -\left(\frac{dQ_i}{dP_i}^{\mathrm{T}}\right)^{-1} Q_i - (P_i - mc_i) = 0$$

Generalized Pricing Pressure (GePP)

Post-merger, the merging partner j does not react:

- d^M holds fixed partner's strategy $\frac{d^M A_i}{dP_i} = \frac{\partial A_i}{\partial P_i} + \frac{\partial A_i}{\partial P_{-ij}} \frac{\partial P_{-ij}}{\partial P_i}$
- The diversion ratio matrix is $D_{ij}^P \equiv -\left(\frac{d^M Q_i}{dP_i}^{-1} \right)^{\mathrm{T}} \frac{d^M Q_j}{dP_i}^{\mathrm{T}}$

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The *Generalized Pricing Pressure* (GePP) is

$$g_i \equiv \underbrace{\tilde{D}_{ij} \left(P_j - MC_j \right)}_{\text{generalized UPP}} - \underbrace{\left[\left(\frac{d^M Q_i}{dP_i}^{-1} \right)^{\mathrm{T}} - \left(\frac{dQ_i}{dP_i}^{-1} \right)^{\mathrm{T}} \right] Q_i}_{\text{end of accommodating reactions}}$$

Note: The two changes (from UPP) go in opposite directions

Examples

Nash-in-Prices

- In single-product case, exactly UPP
- In multi-product case, diversion by matrices

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Nash-in-Quantities

- Only works for differentiated products

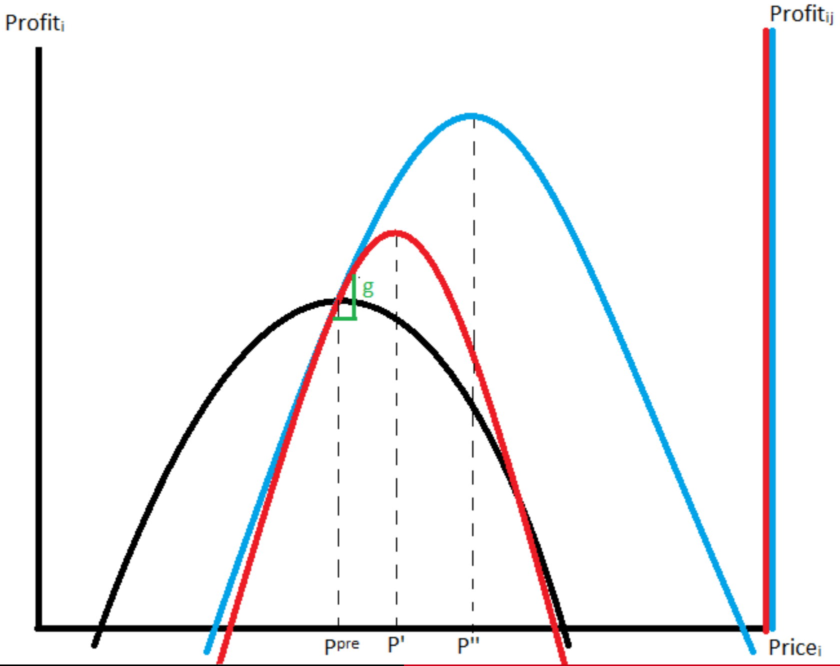
$$g_i(P) = -\underbrace{\frac{\frac{\partial Q_j}{\partial P_i} - \frac{\partial Q_j}{\partial P_{-ij}} \frac{\partial Q_{-ij}}{\partial P_{-ij}}^{-1} \frac{\partial Q_{-ij}}{\partial P_i}}{\frac{\partial Q_i}{\partial P_i} - \frac{\partial Q_i}{\partial P_{-ij}} \underbrace{\frac{\partial Q_{-ij}}{\partial P_{-ij}}^{-1} \frac{\partial Q_{-ij}}{\partial P_i}}_{\text{Price Response}}}}_{\text{Diversion Ratio}} (P_j - \mathrm{mc}_j)$$

$$-\underbrace{\left(\frac{1}{\frac{\partial Q_i}{\partial P_i} - \frac{\partial Q_i}{\partial P_{-ij}} \frac{\partial Q_{-ij}}{\partial P_{-ij}}^{-1} \frac{\partial Q_{-ij}}{\partial P_i}} - \frac{1}{\frac{\partial Q_i}{\partial P_i} - \frac{\partial Q_i}{\partial P_{-i}} \frac{\partial Q_{-i}}{\partial P_{-i}}^{-1} \frac{\partial Q_{-i}}{\partial P_i}} \right) Q_i}_{\text{End of Accommodating Reactions}}$$

Pass-through

GePP, like UPP, only gives pricing pressure, not price changes

- *Pass-through* is the rate at which changes in marginal cost are passed through to prices
- It's intuitive to think that pass-through rates should be used to convert pricing pressure into price changes
- Disagreement in the literature over which pass-through rate choice
  - Froeb, Tschantza, Werden (2005) claim post-merger
  - Farrell and Shapiro (2010) claim pre-merger


Profit$_i$
Profit$_{ij}$
g
P^{pre}
P'
P''
Price$_i$

We use a Taylor expansion to find the relevant pass-through rate

- Even though mergers are a discrete change in industry structure, we can use standard comparative static approaches as long as the changes in incentives are small
- Requires that the first-order conditions be invertible

Theorem

If f is the vector first-order conditions and g is the vector of GePPs and $(f+g)$ and $\left(\frac{\partial f(P)}{\partial P}+\frac{\partial g(P)}{\partial P}\right)$ are invertible, then,

$$\Delta P \approx \underbrace{-\left(\frac{\partial f(P)}{\partial P}+\frac{\partial g(P)}{\partial P}\right)^{-1}\Bigg|_{P^0}}_{\textit{merger pass-through}} \underbrace{g(P^0)}_{\textit{pricing pressure}} .$$

Pre-, post- and merger pass-through

- Pre-merger: $\rho_{\leftarrow} = -\left(\frac{\partial f}{\partial P}\right)^{-1}$
- Post-merger: $\rho_{\rightarrow} = -\left(\frac{\partial f}{\partial P} + \frac{\partial g}{\partial P}\right)^{-1} \tilde{D}$
  - where $\tilde{D} \equiv \begin{bmatrix} I & -\tilde{D}_{12} & 0 \\ -\tilde{D}_{21} & I & 0 \\ 0 & 0 & I \end{bmatrix}$
- Merger: $\rho = -\left(\frac{\partial f}{\partial P} + \frac{\partial g}{\partial P}\right)^{-1}$
  - Pre-merger cost impacts
    - Opportunity, not physical costs,
  - Post-merger curvature
    - Post-merger incentives

Identifying merger pass-through

We can't directly observe merger pass-through...two approaches:

1. Exact identification
    - Two merging firms
        - Use Slutsky symmetry to identify w/ Bertrand or Cournot
    - With more firms, need stronger assumptions
        - Weyl-Fabinger horizontality or independent discrete choice
2. Approximating merger pass-through with pre-merger pass-through
    - If g is small
        - Then likely that $\frac{\partial g}{\partial P}$ also small $\implies \rho \approx \rho_{\leftarrow}$
        - Otherwise "smallness" not very robust
        - If g is small because D is small $\implies \rho \approx \rho_{\rightarrow}$
    - If merger small, effect on pass-through are likely to also be small

Approximation Error and Validity

The error term $\frac{1}{2}\frac{\partial^2 h^{-1}}{\partial x^2} r^2$, is small whenever:

- g is small
- The first-order conditions are not highly curved in the relevant range.

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Validity

1. Smoothness
   - Standard demand systems in MS have very smooth focs
   - Easier to estimate...and based on pre-merger information

   $\Longrightarrow$ To the extent not smooth, non-parametric unreliable anyway
2. Smallness
   - If merger has large effects, likely to be easier to judge

   $\Longrightarrow$ Detailed quantitative analysis most useful when small

Welfare as a common currency

In the end, we care about Welfare

- Consumer Surplus
  - $\Delta P^{\mathrm{T}} Q$
    - Laspeyres, Paasche, Marshall-Edgeworth or Fisher
  - Normalize by value of trade for unit-free measure

$$\Delta P^{\mathrm{T}} Q / P^{\mathrm{T}} Q$$

- Social Surplus
  - $\Delta DWL \approx (P - \mathrm{mc})^{\mathrm{T}} \Delta Q \approx (P - \mathrm{mc})^{\mathrm{T}} \left(\frac{\partial Q}{\partial P} \widehat{\Delta P} \right)$.
  - Ignores externalities and any other out-of-market affects

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In addition to being what we care about, these

- Aggregate multiple price changes (possibly with mixed signs)
- Allow comparison to other effects

Comparison to merger simulation

"Approximateness"

- With MS's assumptions, we would get the same results
  - Functional forms tie down the higher order Taylor terms
    - But they also tie down pass-through rates
    - We think it's better to try to measure these empirically
  - Our approach makes it clear what the assumptions are
    - And allows for easy testing of different sets of assumptions

Computational ease

- No "simulation" or computation: explicit formula
- Easier to explain

Complementarity

- Might use elasticities from structural estimation

Simplifying the formula for applications

The more general, robust formula requires more inputs

- Many possible simplifying assumptions
  1. Pass-through
  2. Firm heterogeneity
  3. Conduct: Bertrand, Cournot, consistent
- Bertrand conduct, zero cross-pass-through, and unit own pass-through give $\mathrm{UPP}^{\mathrm{T}} \cdot Q$
- Our value added diminishes, but useful for robustness checks

Conclusion

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Future Directions:

1. How accurate is the first-order approximation and when?
2. Add more richness: dynamics, products, quality choice
3. Best ways to simplify the formula in salient cases
4. Empirical work on pass-through