Pass-Through as an Economic Tool

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Wanted: a rebirth of IO theory

- Plea for IO price theory (price theory more broadly?)
- IO theory boomed in 80’s, declined since. Why?
  - You can prove anything!
    - E.g. Bulow et. al. (1985) and Fudenberg and Tirole (1984)
    - All depends on strategic complements v. substitutes...
    - But we don’t know this

- So structural IO: figure out demand system
  - No need for theory (just computation)
  - But identification relies on strong assumptions
  - These might answer theory disputes themselves...

- So theory comes back in: what, how to measure
- Today: example of how this can work
  - Including solution to Bulow et al. and FT dilemma
Introduction

- So what should we measure?
- In competitive markets: elasticities
  - Tax revenues
  - Welfare (Chetty’s sufficient statistics)
- But in IO elasticities = level not comparative statics
- *Pass-through* serves role of elasticities
  1. Many different theory results depend on it
  2. Basis for identification with weak assumptions
  3. Flexibility important, but rare: create demand systems
Examples

1. Double marginalization and Cournot competition
   - Which side of $1 + \text{sign of slope}$
     - Ranking of firm and industry markups/quantities and profits

2. Two-sided markets (Rochet and Tirole 2003)
   - All major positive and normative properties: PT vs. 1

3. Bertrand and Cournot, arbitrary demand
   - Merger effects determined by PT, X-PT
   - Under “Special Theory”
     1. Strategic complements vs. substitutes: PT vs. 1
     2. Short- and long-run idiosyncratic same side as industry PT
     - Conditions satisfied by (simple) discrete choice models
       - PT determines effect of entry on prices
       - Closely linked to log-curvature, so micro tests also

4. International macro: link to price frequency

Weyl (2008)
Overview

1. Review pass-through, new results on why matters
2. Simple example: Cournot’s two problems
3. Other applications
   - Two-sided markets
   - Mergers
   - Special theories of oligopoly
   - Discrete choice
4. Taxonomy of functional forms
5. Apt demand
6. Conclusion and directions for research
Monopoly pricing

- Standard monopolist problem \( (p, D(\cdot), c) \)
- FOC:
  \[
  m \equiv p - c = -\frac{D(p)}{D'(p)} \equiv \mu(p)
  \]

- Only first-order condition
- Standard condition for sufficiency is log-concavity, \( \mu' < 0 \)
  - But grossly sufficient
    \[
    \rho \equiv \frac{dp_M}{dc} = \frac{1}{1-\mu'} \text{ so log-concave } \iff \text{“cost-absorbing”}
    \]
  - Weakest condition for same tractability gain:
    \( \mu' < 1 \iff MR'(Q) < 0 \iff \frac{1}{D} \text{ convex} \)
    - Mark-up contraction (MUC)
    - Always charge at binding price control for all \( c \)

Weyl (2008)
Useful properties of pass-through

Pass-through crucial parameter, two reasons:

1. Measures sharpness of monopoly problem
   \[ \rho = \frac{1}{\frac{d^2 \pi}{dm^2}} \]
   - Quantity parallel
   - “Pass-through” of pre-existing units \( \rho_Q = \rho \)

2. Determines division of surplus
   - Monopoly profits at optimum are \( \mu(p_M)D(p_M) \)
   - Consumer surplus is \( V(p_M) = \int_{p_M}^{\bar{p}} D(p)dp \)
   - Fabinger and Weyl (2008) show \( \forall p < \bar{p} \) (choke price):

\[
\frac{V(p)}{\mu(p)D(p)} = \bar{\rho}(p) \equiv \int_{p}^{\bar{p}} \lambda(q; p)\rho(q) dq
\]

where \( \int_{p}^{\bar{p}} \lambda(q; p) dq = 1 \)

- Ratio of surpluses determined by average of pass-through
**Taxonomy of demand**

- **Three types of demand**
  1. $\rho < 1 \iff \mu' < 0$: cost absorption (Rochet-Tirole 2007)
  2. $\rho = 1 \iff \mu' = 0$: constant mark-up
  3. $\rho > 1 \iff \mu' > 0$: cost amplification

- **Increasing vs. decreasing in cost**

**Assumption**

*Demand globally one combination*

- Can be substantially weakened, but clean
- Obeyed by almost every demand (shown below)
Cournot (1838)-Spengler (1950) model

Detailed, simple example to show how it works

- Two goods:
  - Perfect complements (Cournot)
  - One input to other (Spengler)
- Total (linear) cost $c_i$
- Baseline case integrated monopoly, optimal mark-up $m_i^*$
- Two separated organizations
Spengler-Stackelberg organization

\[
\begin{align*}
    m^*_U &= \frac{\mu (m^*_U + m^*_D + c_I)}{\rho (m^*_U + m^*_D + c_I)} \\
    m^*_D &= \mu (m^*_U + m^*_D + c_I)
\end{align*}
\]

\[m^*_S = m^*_D + m^*_U\]

Upstream

\[\pi^*_U\]

\[m^*_U\]

Downstream

\[\pi^*_D\]

\[m^*_D\]

Consumer

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Cournot-Nash organization

\[ m^*_A = \mu (m^*_A + m^*_B + c_I) \]
\[ m^*_B = \mu (m^*_A + m^*_B + c_I) \]

\[ m^*_N = 2 m^* \]
Graphical summary of results

<table>
<thead>
<tr>
<th>$\rho$ $&lt; 1$</th>
<th>$\rho &gt; 1$</th>
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<tbody>
<tr>
<td><strong>Cost absorption</strong></td>
<td><strong>Cost amplification</strong></td>
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<tr>
<td>Decreasing pass-through</td>
<td>Decreasing pass-through</td>
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<tr>
<td>$m_U^*$</td>
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<td>$\vee$</td>
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<td>$m_i^* &lt; m_N^* &lt; m_S^*$</td>
<td>$\pi_U^*$</td>
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<td>$m_D^*$</td>
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**Table:** A taxonomy of the Cournot-Spengler double marginalization

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Explaining the results

- \( \pi^*_U > \pi^* \)
- \( \rho \) v. 1 crucial
  - Determines strategic complements v. substitutes
  - \( m^* \) v. \( m^*_i \): magnify or absorb 2nd mark-up
  - \( m^*_U \) v. \( m^*_D \) (\( \pi^*_U \) v. \( \pi^*_D \)): what lowers \( m^*_D \)?
  - Everything else except \( m^*_U \) v. \( m^*_i \) determined by same

- \( m^*_U \) v. \( m^*_i \) more subtle
  - How much of \( m_D \) to pass-through vs. strategic effect
  - Marginal vs. average
    - Pass-through increasing or decreasing?

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Double marginalization = dual of quantity competition

⇒ Switching quantity for price, all results here hold with $\rho_Q$

- But how to identify $\rho_Q, \rho_Q'$?

- Link between quantity and cost $\rho$ (even in equilibrium)
  
  - Equilibrium Cournot pass-through $\rho_C$
    (symmetric linear cost duopoly)
  
  - $\rho_Q = \frac{2\rho_C}{2+\rho_C} < 1 \iff \rho_C < 2$ and
  
    $\rho_Q'(Q) < 0 \iff \rho_C'(c) > 0$

- Thus identification proceeds in *exactly* same way
Two-sided markets

- Two-sided market: cross-network effects
- Payment cards, video games, television, etc.
- Value partners linearly (Rochet and Tirole 2006)
  - Per-interaction heterogeneity (RT2003)
  - Fixed heterogeneity (Armstrong 2006)

- Both analyzed using pass-through, today RT2003
  - Visa and cross-subsidies
  - Only cross-effect
    - $\Rightarrow$ Pass-through of cross-subsidies crucial
  - Externality=average surplus, only marginal internalized
    - Also determined by pass-through!
    - $\Rightarrow$ Everything turns on both cost-absorb vs. one cost-amp

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Static unilateral effects of mergers from Bertrand competition

- How much are efficiencies passed-through?
- Anti-competitive effect is opportunity cost from diversion (Froeb et. al. 2005, Farrell and Shapiro 2008)
  \[ \text{⇒ Diversion-efficiencies=sign, pass-through=magnitude} \]
- Avoids pitfalls of functional form, but ignores...
  - Interactions between anti-competitive effects
  - Effects on (and through) other firms’ pricing
- To solve, new “constant pass-through demand system”
  \[ D^i(p) = \lambda \left( \alpha_i [\rho_i - 1] \left[ p_i + \sum_{j \neq i} \beta_{ji} p_j \right] \right)^{\frac{\rho_j}{1-\rho_j}} \]
- Allows full variation in pass-through
- Also useful: linearity, second-order conditions, mergers, etc.
- Works for differentiated Cournot as well
- But no Slutsky symmetry...

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The “Special” theories of oligopoly

- General theories: Bertrand/Cournot with arbitrary demand
  - Little first-order empirical content (from cost shocks)
    - How to figure out strategic substitutes vs. complements?
    - Why people turned away from IO theory...prove anything
  - Only stability-based inequalities, positive idiosyncratic PT
- Intuitive assumptions, via PT, give much more identification
  - Two “natural” ways for other price to effect your demand
    1. Horizontal shift (willingness to pay)
    2. Vertical shift (demand level)
  - To second order, only two ways

Assumption

Other price effects weakly convex mixture of horizontal, vertical

Mutatis mutandis for Cournot

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Under these assumptions

1. Three notions of PT all on same side of 1:
   1. Short-run idiosyncratic
   2. Long-run idiosyncratic
   3. Industry (in symmetric model)

2. Pass-through + Bertrand v. Cournot $\implies$ strategic effect
   - Thus “conventional wisdom” reversed when $\rho > 1$
   - Identifies lots (Bulow et. al. and Fudenberg and Tirole)
   - Yes, it depends, but we know what it depends on!
     - Solves the Bulow et. al.-FT challenge

3. This implies many first-order testable restrictions
Most empirical work uses discrete choice models

- Simple discrete choice models fall under Special theory
- We think more complicated may as well
- Robust preservation of log-concavity under transformations
  \[ \Rightarrow \text{Demand same log-curvature as idiosyncratic errors} \]
  - Assumptions about errors \[ \Rightarrow \text{assumption on demand} \]
  - May give test for PT based on discrete choice

- Effect of competition on prices driven by log-curvature
  - Strategic complementarity vs. substitution
- Linear (CoPaDS) demand also falls under special theory

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### Common demand functions

<table>
<thead>
<tr>
<th>$\rho'$</th>
<th>$\rho &lt; 1$</th>
<th>$\rho &gt; 1$</th>
<th>Price-dependent</th>
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<tbody>
<tr>
<td>∧ 0</td>
<td>Normal (Gaussian)</td>
<td>Type II Extreme Value (Fréchet) with shape $\alpha &gt; 1$</td>
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<tr>
<td></td>
<td>Logistic</td>
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<td>AIDS</td>
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<td>Type I Extreme Value (Gumbel)</td>
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<td>Double Exponential</td>
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<td>Type III Extreme Value (Reverse Weibull)</td>
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<td>Weibull with shape $\alpha &gt; 1$</td>
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<td>Gamma with shape $\alpha &gt; 1$</td>
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<thead>
<tr>
<th>Price-dependent</th>
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<tbody>
<tr>
<td>Does not globally satisfy MUC</td>
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</table>

| Type II Extreme Value (Fréchet) with shape $\alpha < 1$ |
| Weibull with shape $\alpha < 1$ |
| Gamma with shape $\alpha < 1$ |

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How can we get flexibility (and tractability)?

- Generalize Bulow-Pfleiderer constant PT demand

\[ D(p) = \lambda \left( |\bar{\rho} - 1| \sqrt{|p - \tilde{p}|} - 2\bar{\rho} \alpha \right)^{2\bar{\rho}} \]

- Apt demand (modulo technicalities)
- Also inverse demand formulation
Many nice properties

1. All nice standard demand assumptions
2. Flexible on level, elasticity, PT and slope of PT
3. Quadratic solutions to monopoly pricing
   - And simple explicit solution to very wide range
4. Generalizes all known tractable demand (Bulow-Pfeiferer)
   - Linear
   - Constant elasticity
   - Negative exponential
5. Easily estimated
6. Simple closed form surplus, estimates from formula

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Where I’m going

1. Non-parametric empirical content/sufficient stats
2. Non-parametric tests
3. Demand systems

What others are doing

1. Collusion and PT (Carrasco)
2. Price frequency + pass-through (Gopinath and Itskhoki)
3. Generalizations on costs (Dejarnette)

Where future might go

- Identifying assumptions
  - Statistical relaxations
  - Economic foundations
- Auction theory?

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