Pass-through as an Economic Tool

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Theoretical slides
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Wanted: IO theory for empirics

- Plea to bring IO theory back into structural IO
- IO theory boomed in 80's, declined since in US. 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 (Bresnahan)
  - No need for theory, just computation (BLP)
  - But identification relies on strong assumptions
  - Assume the result sometimes?
- So theory comes back in: what, how to measure
- Implications of (functional form) assumptions
- Today: simple example
  - Demand shape restrictions important for theory

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. Generalized Cournot-Stackelberg (GCS) models
   - Which side of 1+sign of slope $\Longrightarrow$
     - Ranking of firm and industry markups/quantities and profits
2. Two-sided markets (Rochet and Tirole 2003)
   - Positive and normative properties: PT v. 1, sign of slope
3. Symmetric multiproduct models (Cournot or Bertrand)
   - Merger effects determined by PT
   - With horizontal demand
     1. Strategic complements v. substitutes: PT v. 1
     2. Short- and long-run idiosyncratic same side as industry PT
   - For example: many firm Berry, Levinsohn and Pakes (1995)

   $\Longrightarrow$ PT determines effect of entry, mergers on prices
     - Closely linked to log-curvature, so micro tests also
4. International macro: link to price frequency

Overview

1. Review pass-through, new results on why matters
2. Illustrate with GCS models
3. Two generalizations
   - Two-sided markets
   - Multiple products, mergers
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
  - $\rho \equiv \frac{dp_M}{dc} = \frac{1}{1-\mu'}$ so log-concave $\iff$ "cost-absorbing"
- Weakest condition for same tractability gain: $\mu' < 1 \iff MR'(Q) < 0 \iff \frac{1}{D}$ convex
  - Mark-up contraction (MUC)

$\iff$ Always charge at binding price control for all c

Useful properties of pass-through

Pass-through crucial parameter, two reasons:

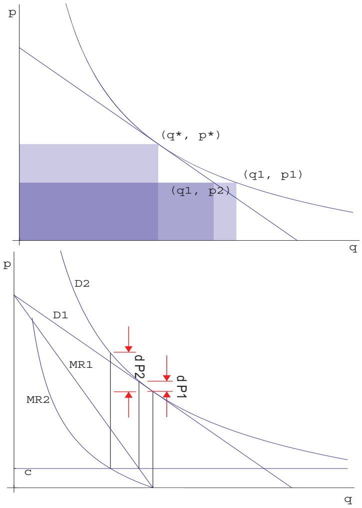
1. Measures sharpness of monopoly problem
   $\rho = \frac{1}{-\frac{d^2\pi}{dm^2}\frac{m^2}{\pi}}$
   - Quantity parallel
   - "Pass-through" of pre-existing units $\rho_Q = \rho$
2. Determines division of surplus
   - Surplus V and profits $\pi = \mu D$ (at optimal price)
   - For all prices $p < \overline{p}$ (choke price)

$$\frac{V(p)}{\mu(p)D(p)} = \overline{\rho}(p) \equiv \int_p^{\overline{p}} \lambda(q;p)\rho(q)dq$$

where $\int_p^{\overline{p}} \lambda(q;p)dq = 1$

- Ratio of surpluses determined by average of pass-through
- Deadweight loss as well

Graphical proof of pass-through properties



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

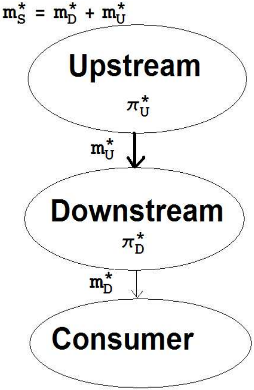
- Can be substantially weakened, but clean
- Obeyed by almost every demand (shown below)
- Which side does demand typically lie on?
  - CE amplifying, linear absorbing; both constant PT
  - Empirical evidence: little, roughly 70-30 absorbing
  - No evidence on slope

Cournot (1838)-Spengler (1950) model

- Detailed, simple example to show how it works
  - Generalization mentioned below to GCS models
- Two goods:
  - Perfect complements (Cournot)
  - One input to other (Spengler)
- Total (linear) cost c_I
- Baseline case integrated monopoly, optimal mark-up $m_I^\star$
- Two separated organizations

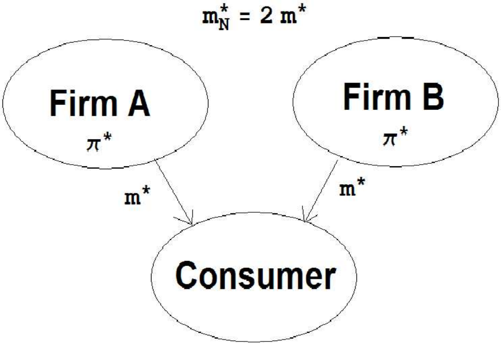
Spengler-Stackelberg organizaiton

$$m_U^\star = \frac{\mu(m_U^\star + m_D^\star + c_I)}{\rho(m_U^\star + m_D^\star + c_I)}$$
$$m_D^\star = \mu(m_U^\star + m_D^\star + c_I)$$



Cournot-Nash organization

$$m_A^\star = \mu(m_A^\star + m_B^\star + c_I)$$
$$m_B^\star = \mu(m_A^\star + m_B^\star + c_I)$$



Graphical summary of results

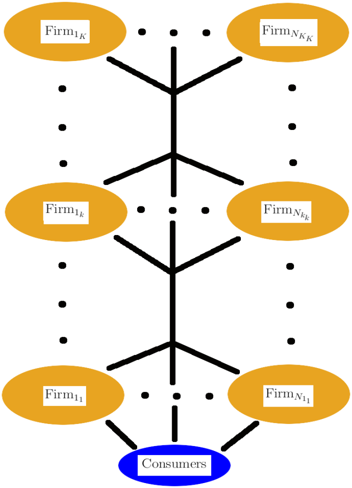
	$\rho < 1$		$\rho > 1$	
ρ' $\wedge$ 0	Cost absorption Decreasing pass-through $m^\star_U$ $\vee$ $m^\star_I < m^\star_N < m^\star_S$ $\vee$ $m^\star$ $\vee$ $m^\star_D$	$\pi^\star_U$ $\vee$ $\pi^\star$ $\vee$ $\pi^\star_D$	Cost amplification Decreasing pass-through $m^\star$ $\vee$ $m^\star_D$ $\vee$ $m^\star_U$ $\vee$ $m^\star_I < m^\star_S < m^\star_N$	$\pi^\star_D$ $\vee$ $\pi^\star_U$ $\vee$ $\pi^\star$
ρ' $\vee$ 0	Cost absorption Increasing pass-through $m^\star_I < m^\star_N < m^\star_S$ $\vee$ $m^\star_U$ $\vee$ $m^\star$ $\vee$ $m^\star_D$	$\pi^\star_U$ $\vee$ $\pi^\star$ $\vee$ $\pi^\star_D$	Cost amplification Increasing pass-through $m^\star$ $\vee$ $m^\star_D$ $\vee$ $m^\star_I < m^\star_S < m^\star_N$ $\vee$ $m^\star_U$	$\pi^\star_D$ $\vee$ $\pi^\star_U$ $\vee$ $\pi^\star$

Table: A taxonomy of the Cournot-Spengler double marginalization

Explaining the results

- $\pi_U^\star > \pi^\star$
- ρ v. 1 crucial
  - Determines strategic complements v. substitutes
  - $m^\star$ v. $m_I^\star$: magnify or absorb 2nd mark-up
  - $m_U^\star$ v. $m_D^\star$ ($\pi_U^\star$ v. $\pi_D^\star$): what lowers $m_D^\star$?
  - Everything else except $m_U^\star$ v. $m_I^\star$ determined by same
- $m_U^\star$ v. $m_I^\star$ more subtle
  - How much of m_D to pass-through vs. strategic effect
  - Marginal vs. average
    - Pass-through increasing or decreasing?

Generalization to GCS models



Quantity competition: Sonnenschein (1968)

Double marginalization = dual of quantity competition

$\Longrightarrow$ Switching quantity for mark-up, all results here hold with ρ_Q

- But how to identify ρ_Q, ρ'_Q?
- Cost shocks work just as well
  - Firm specific cost shock: $\frac{dq}{d\tilde{q}} = -\frac{m^\star}{q^\star}\frac{dq}{dc}$
  - Works for general GCS model
  - Intuition: link between cost-price and quantity pass-through
- 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)
  - 2d heterogeneity: membership and interaction benefits
- RT2003: only interaction benefits/costs
  - Visa and cross-subsidies
  - Only cross-effect

  $\Longrightarrow$ Pass-through of cross-subsidies crucial

  - Externality=average surplus, only marginal internalized
    - Also determined by pass-through!

  $\Longrightarrow$ Much turns on pass-through, slope

Mergers

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)

$\implies$ 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"
  - $D^i(\mathbf{p}) = \lambda \left([\rho_i - 1] \left[p_i + \sum_{j \neq i} \beta_{ji} p_j - \tilde{p}_i \right] \right)^{\frac{\rho_i}{1-\rho_i}}$
  - Allows full variation in pass-through
  - Also useful: linearity, second-order conditions, mergers, etc.
  - Differentiated Cournot as well (Singh and Vives, 1984)
  - But no Slutsky symmetry

Symmetric horizontal demand systems

- General theories: Bertrand/Cournot with arbitrary demand
  - Little first-order empirical content (from cost shocks)
    - E.g. Bulow et. al. (1985), Fudenberg and Tirole (1984)
    - How to figure out strategic substitutes v. complements?
  - Only stability-based inequalities, positive idiosyncratic PT
- With a bit more structure gives a lot of identification
  - Working to generalize...
- Two assumptions:
  1. Symmetry across firms
  2. Horizontal demand system
     - $D_i(p_i, \mathbf{p}) = \tilde{D}(p_i - g[\mathbf{p}_{-i}])$
     - Increasing price of substitute increases willingness to pay
     - Linear, CoPaDS special cases

Results with symmetric horizontal demand

Under these assumptions

1. Three notions of PT all on same side of 1:
   1. *Short-run own* (Sop)
   2. *Long-run own* (Lop)
   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)
3. Effects of entry, merger on other prices

$\rho < 1$

	Substitutes	Complements
Bertrand	Strategic complements	Strategic substitutes
Cournot	Strategic substitutes	Strategic complements

$\rho > 1$

	Substitutes	Complements
Bertrand	Strategic substitutes	Strategic complements
Cournot	Strategic complements	Strategic substitutes

Effects of market conditions on pass-through

- Also how primitives affect various pass-through rates
- *Assuming constant marginal cost*:
  1. Sop $\uparrow \implies$ Lop, industry $\uparrow$,more strategic substitutes
  2. N $\uparrow$ Lop, industry $\downarrow$, less interaction
  3. Less differentiation $\implies$ industry $\to$ 1, Lop $\uparrow$
     - Counterintuitive? See below
     - Can't pass-through, but can't afford not to
- Strategic effects opposite when complements
- When marginal cost non-constant
  - Increasing marginal cost just like low pass-through
  - Increasing competition makes cost more important
  - Competitive, near constant MC $\implies$ compare elasticities

Discrete choice models

Most empirical work uses discrete choice models

- These models are hard to analyze for pricing
- But using recent formula of Gabaix et. al. (2009) by EVT....
- Non-parametric symmetric many firm BLP is horizontal
- We think more complicated may as well
  - Intuitive link
- Robust preservation of log-concavity under transformations

$\Longrightarrow$ Demand same log-curvature as idiosyncratic errors
  - Assumptions about errors $\Longrightarrow$ assumption on demand
  - May give test for PT based on discrete choice
- Effect of competition on prices driven by log-curvaure
  - Strategic complementarity vs. substitution
- So allowing flexibility in pass-through, slope important...

Common demand functions

	$\rho < 1$	$\rho > 1$	Price-dependent
$\rho' < 0$			AIDS
$\rho' > 0$	Normal (Gaussian) Logistic Type I Extreme Value (Gumbel) Double Exponential Type III Extreme Value (Reverse Weibull) Weibull with shape $\alpha > 1$ Gamma with shape $\alpha > 1$		Type II Extreme Value (Fréchet) with shape $\alpha > 1$
Price-dependent			
Does not globally satisfy MUC		Type II Extreme Value (Fréchet) with shape $\alpha < 1$ Weibull with shape $\alpha < 1$ Gamma with shape $\alpha < 1$	

Apt demand (with Fabinger)

How can we get flexibility (and tractability)?

- Generalize Bulow-Pfleiderer constant PT demand

$$D(p) = \lambda \left(|\overline{\rho} - 1| \sqrt{|p - \tilde{p}|} - 2\overline{\rho}\alpha \right)^{\frac{2\overline{\rho}}{1-\overline{\rho}}}$$

- Apt demand (modulo technicalities)
- Also inverse demand formulation

Properties of Apt demand

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-Pfleiderer)
    - Linear
    - Constant elasticity
    - Negative exponential
5. Easily estimated
6. Simple closed form surplus, estimates from formula
7. Software we made makes easy to use

Where now?

Important direct extensions

1. Non-symmetric multi-product models
2. More general connection to discrete choice/empirical IO
    - Vertical differentiation (Bennot had thought)
3. Demand systems: discrete choice

Others' applications

1. Price frequency + pass-through (Gopinath-Itskhoki)
2. Third-degree price discrimination (Aguirre, Cowan,Vickers)
3. Price controls on consumer welfare (Bulow-Klemperer)

Where future might go

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