Pass-Through as an Economic Tool

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Motivation

> [F]or many questions of policy analysis, it is not necessary to identify fully specified economic models that are invariant to classes of policy modifications. All that may be required for any policy analysis are combinations of subsets of the structural parameters, corresponding to the parameters required to forecast particular policy modifications, which are often much easier to identify (i.e. require fewer and weaker assumptions).

–Heckman and Vytlacil (2007) describe Marschak's Maxim

Or: "It's better to do one thing well than many things poorly."

Introduction

- For example: elasticities in competitive models
  - Will raising tax raise revenue?
  - “Sufficient statistics” for welfare (Chetty 2008)
- What about IO? Chetty raises two problems
  1. IO concerned with strategic interactions

     $\Longrightarrow$ Elasticities determine levels, not comparative statics
     - Solution: pass-through plays same role as elasticities
  2. Often concerned with non-local changes
     - Solution: simple, intuitive assumptions sufficient
     - E.g. Pass-through globally on one side of 1 +
     - Local estimate of pass-through

     $\Longrightarrow$ Identification, testing of many models
     - Global changes “made up of” local chages

Examples

1. Double marginalization and Cournot competition
   - 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)
   - All major positive and normative properties: PT v. 1
3. Bertrand and Cournot, arbitrary demand
   - Merger effects determined by PT, X-PT
   - Under "Special Theory"
     1. Strategic complements v. substitutes: PT v. 1
     2. Short- and long-run idiosyncratic same side as industry PT
   - Conditions satisfied by (simple) discrete choice models

   $\Longrightarrow$ PT determines effect of entry 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. Simple example: Cournot's two problems
3. Other applications
   - Two-sided markets
   - Mergers
   - Special theories of oligopoly
   - Discrete choice
4. Estimating pass-through, 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
   - Monopoly profits at optimum are $\mu(p_M)D(p_M)$
   - Consumer surplus is $V(p_M) = \int_{p_M}^{\overline{p}} D(p)dp$
   - Fabinger and Weyl (2008) show $\forall p < \overline{p}$ (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

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
- To consider non-local changes:

Assumption

Demand globally one combination

- Can be substantially weakened, but clean
- Obeyed by almost every demand (shown below)

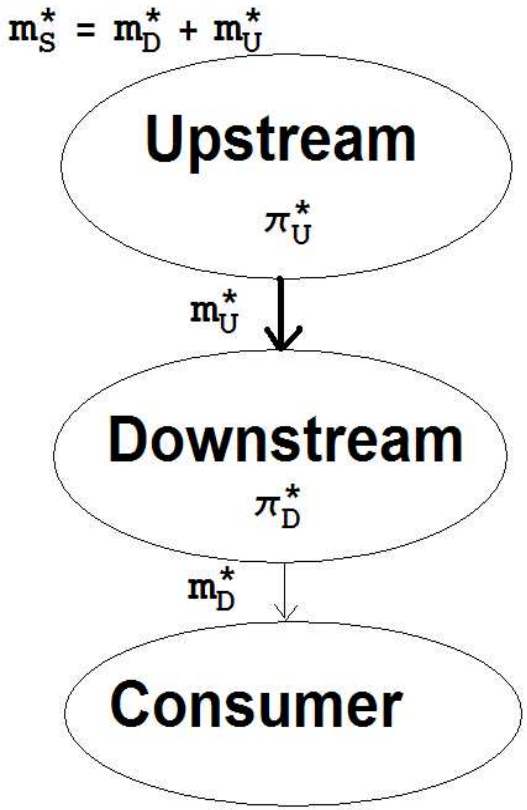
Cournot (1838)-Spengler (1950) model

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 $m_I^\star$
- Two separated organizations

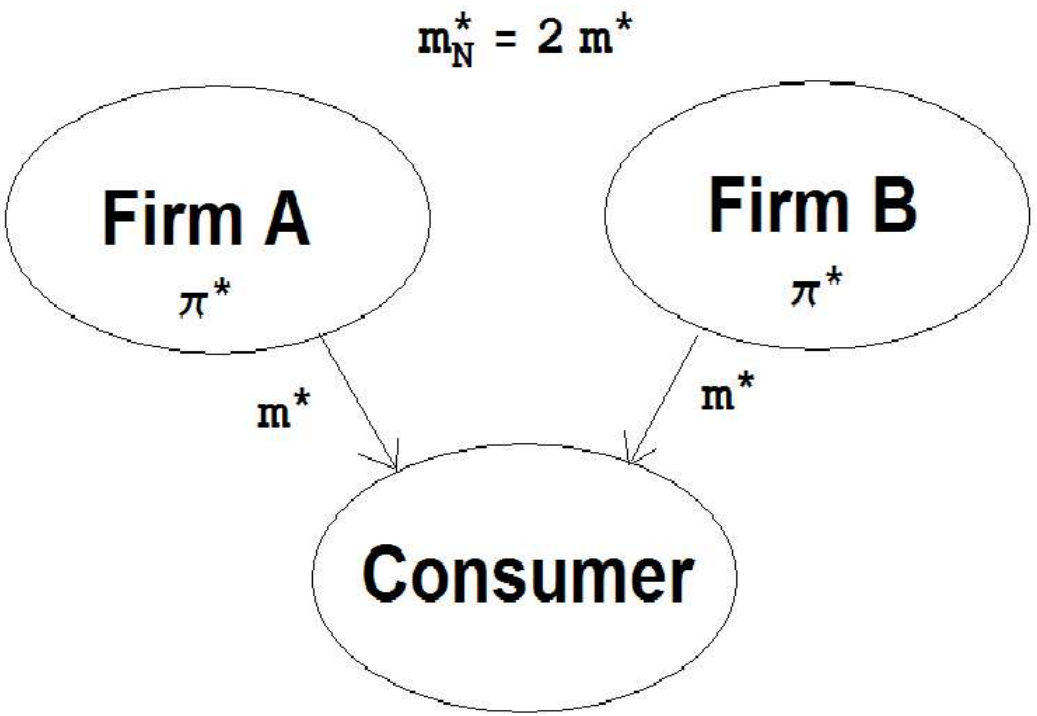
Spengler-Stackelberg organizaiton

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



Cournot-Nash organization

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



Graphical summary of results

	$\rho < 1$		$\rho > 1$	
	Cost absorption Decreasing pass-through		Cost amplification Decreasing pass-through	
ρ'	$m_U^\star$ $\vee$	$\pi_U^\star$	$m^\star$ $\vee$	$\pi_D^\star$
$\wedge$	$m_I^\star < m_N^\star < m_S^\star$	$\vee$	$m_D^\star$	$\vee$
0	$\vee$	$\pi^\star$	$\vee$	$\pi_U^\star$
	$m^\star$	$\vee$	$m_U^\star$	$\vee$
	$\vee$	$\pi_D^\star$	$\vee$	$\pi^\star$
	$m_D^\star$		$m_I^\star < m_S^\star < m_N^\star$	
	Cost absorption Increasing pass-through		Cost amplification Increasing pass-through	
	$m_I^\star < m_N^\star < m_S^\star$		$m^\star$	
ρ'	$\vee$	$\pi_U^\star$	$\vee$	$\pi_D^\star$
$\vee$	$m_U^\star$	$\vee$	$m_D^\star$	$\vee$
0	$\vee$	$\pi^\star$	$\vee$	$\pi_U^\star$
	$m^\star$	$\vee$	$m_I^\star < m_S^\star < m_N^\star$	$\vee$
	$\vee$	$\pi_D^\star$	$\vee$	$\pi^\star$
	$m_D^\star$		$m_U^\star$	

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?

Applications and connections

- Testing the model
- Identifying pass-through rates, using for antitrust
- Vertical tax relationships
- Endogenous timing
- When integration most valuable (spin-off most harmful)?
  - From Nash: ρ large
  - Stackelberg: ρ large but more importantly $\rho' \ll 0$
- Analytic tool for inter-temporal complementarity without firm commitment (addictive goods, switching costs, tying)

Quantity competition: Sonnenschein (1968)

Double marginalization = dual of quantity competition

$\Longrightarrow$ Switching quantity for price, all results here hold with ρ_Q

- But how to identify ρ_Q, ρ'_Q?
- Link between quantity and cost ρ (even in equilibrium)
  - Equilibrium Cournot pass-through ρ_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

    $\Longrightarrow$ Pass-through of cross-subsidies crucial
  - Externality=average surplus, only marginal internalized
    - Also determined by pass-through!

    $\Longrightarrow$ Everything turns on both cost-absorb vs. one cost-amp
  - Easy to (over-)identify

Double marginalization in two-sided markets

- Debit industry problem
  - Combine double marginalization and two-sided markets
- Might worry that more complicated problem less identified
  - Actually over-identification multiplies!
  - Hopeful for other problems

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)

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

The "Special" theories of oligopoly

- 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?
    - 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

Identification from Special theories

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 $\Longrightarrow$ 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!
3. This implies many first-order testable restrictions

Discrete choice models (with Fabinger)

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

  $\Longrightarrow$ 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
- Linear (CoPaDS) demand also falls under special theory

Measuring pass-through

Several ways to measure pass-through

1. Quantitative exogenous cost shocks
   - Exchange rates, taxes, inputs
   - Exogenous shock from instrument (+cost measurement)
   - Must be uncorrelated with (certain properties of) demand
     - Or explicit oligopoly with higher dimension
2. Structural recovery from observable
3. Second-order quantity data
4. Discrete choice log-curvature tests (coming soon...)
5. Structural demand estimation
   - But must allow variation in pass-through
   - Or higher order (general problem)
   - But most functional forms severely restrict!
     - Recall idiosyncratic error-demand link

Common demand functions

	$\rho < 1$	$\rho > 1$	Price-dependent
ρ' $\wedge$ 0			AIDS
ρ' $\vee$ 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 to very wide range
4. Generalizes all known tractable demand (Bulow-Pfleiderer)
   - Linear
   - CES
   - Negative exponential
5. Easily estimated
6. Simple closed form surplus, estimates from formula

Structural IO v. me

How does my approach compare to BLP?

- BLP doesn't take much analysis
  - Immediately answers lots of questions
- But if you take the time, can do better
  - Lots of questions I haven't answered
    - How to use product characteristic data?
    - Income shocks, dynamics, predation, innovation, etc.
  - There you need to do structural, or try analyzing in my style
    - Even here, PT-flexible structure may help
- Neither approach deals with bad maintained assumptions
  - Though maybe mine lets you credibly test them

Where now?

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
- More on welfare (add in Chetty)
- Auction theory?