Pass-through as an Economic Tool

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Applied slides
June 2009

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 2009)
- 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. 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. Empirics and 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

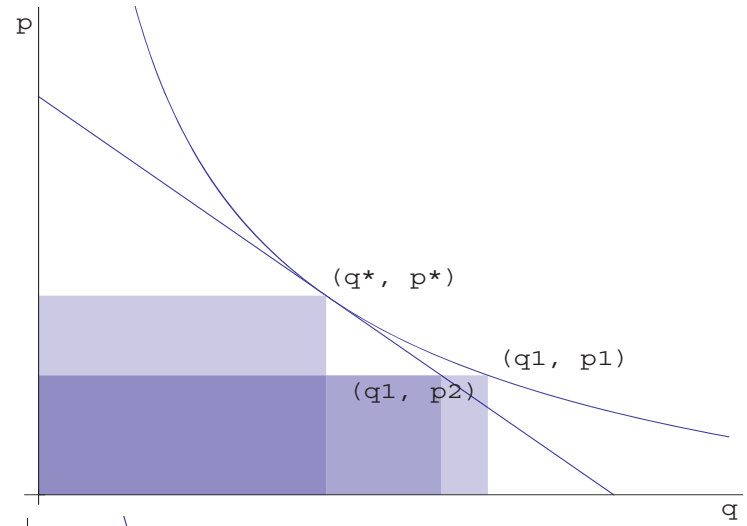
   - Surplus V and profits $\pi = \mu D$ (at optimal price)
   - For all prices $p < \overline{p}$ (choke price)

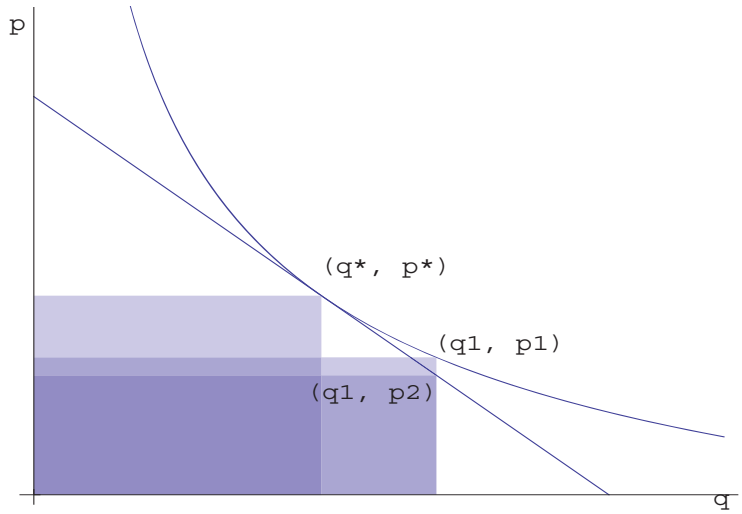
$$\frac{V(p)}{\mu(p)D(p)} = \overline{\rho}(p) \equiv \int_p^{\overline{p}} \lambda(q;p)\rho(q)dq$$

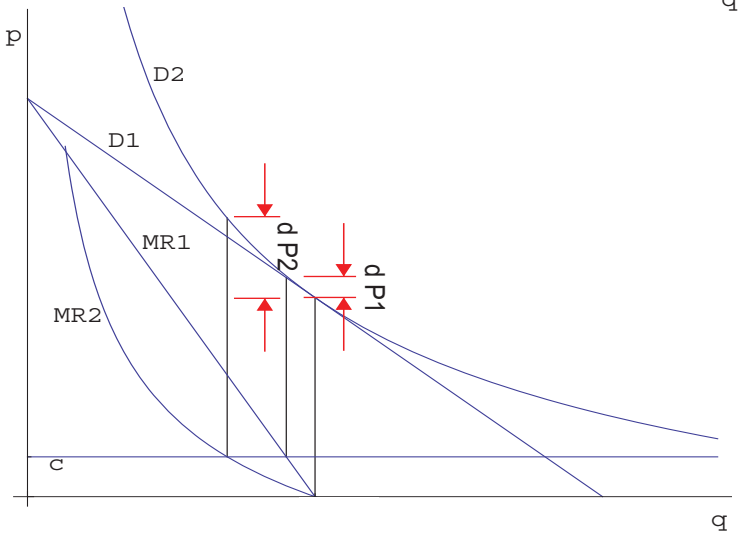
where $\int_p^{\overline{p}} \lambda(q;p)dq = 1$

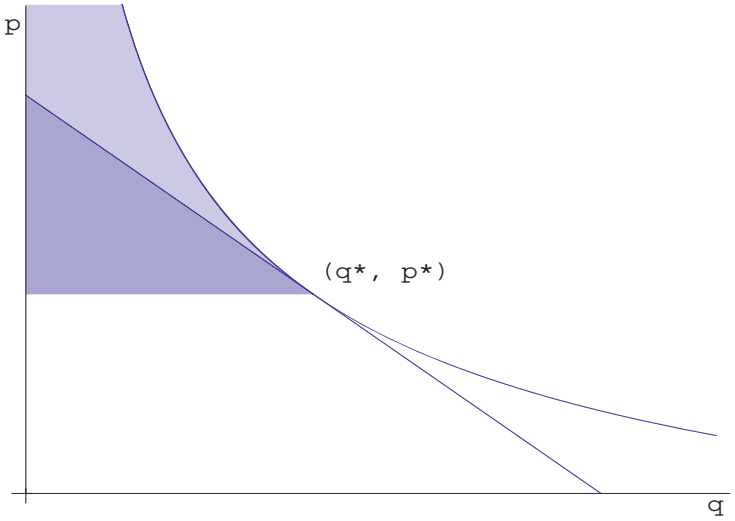
- Ratio of surpluses determined by average of pass-through
- Deadweight loss as well

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)

Empirical evidence on pass-through

- Evidence we have not ideal
  1. Industry-wide
     - Tax studies find amplification a bit more common
     - Exchange rate finds absorption
  2. Messy, small sample individual firm in industry
     - Ashenfelter et. al. (1998) and Besanko et. al. (2001) find absorption
  3. Multiproduct monopoly
     - Many find mixture
     - Besanko et. al. (2005) say about 70-30
  4. Einav, Finkelstein and Cullen (2009)
     - First relatively clean 2nd-order demand estimate
     - Quite concave (PT<.5)
     - Very particular industry of course

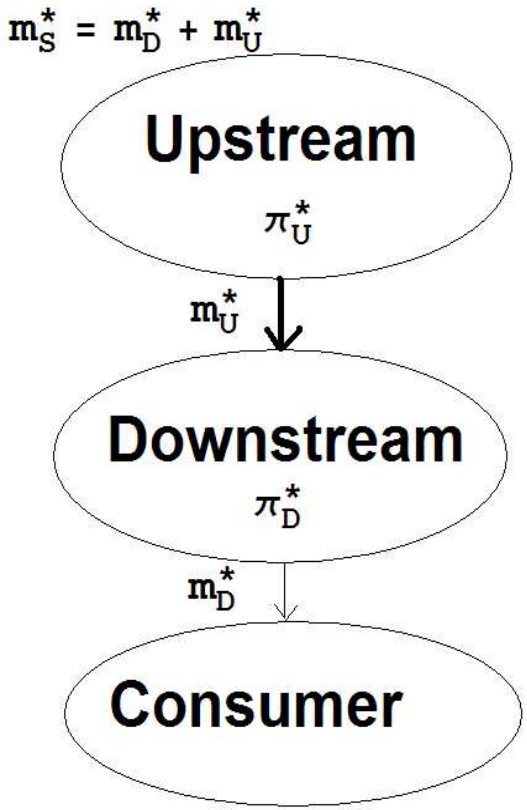
$\Longrightarrow$ We really don't know (no strong evidence)

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

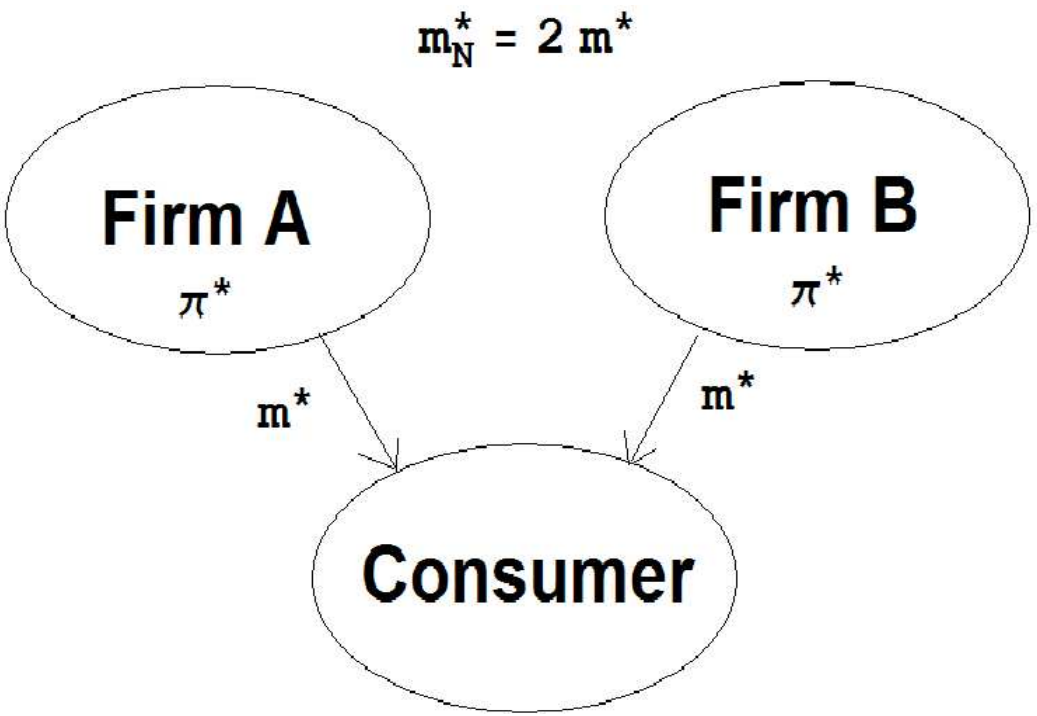
Spengler-Stackelberg organizaiton

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



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

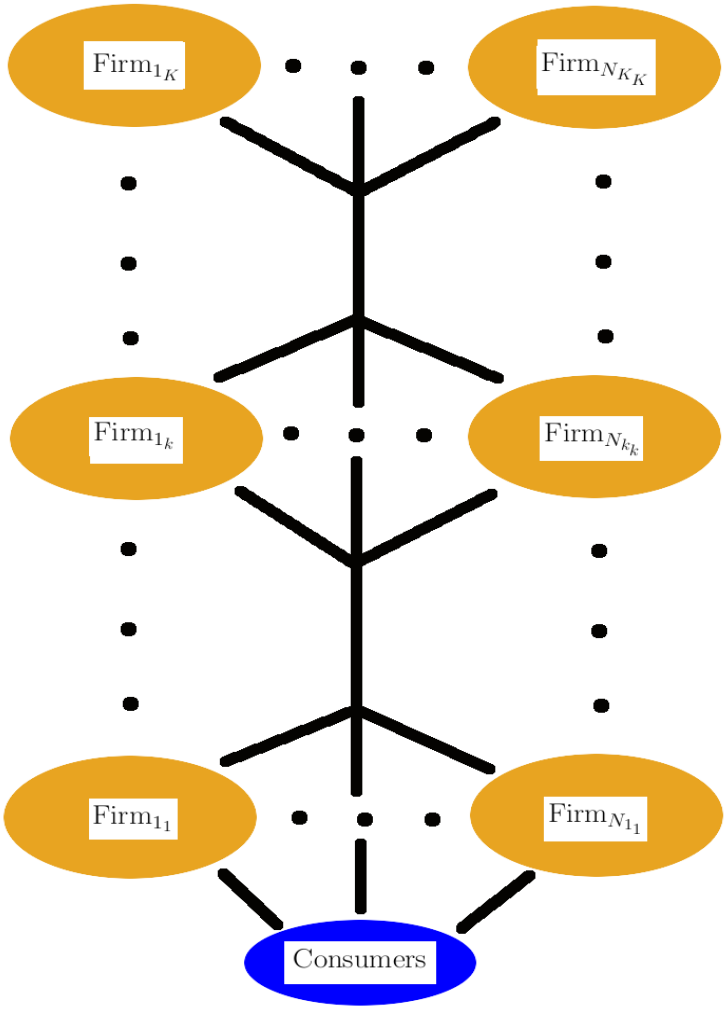
	$\rho < 1$		$\rho > 1$	
	Cost absorption Decreasing pass-through		Cost amplification Decreasing pass-through	
ρ'	$m_U^\star$ $\vee$	$\pi_U^\star$	$m^\star$ $\vee$	$\pi_D^\star$
$\wedge$	$m_I^\star < m_N^\star < m_S^\star$	$\vee$	$m_D^\star$	$\vee$
0	$\vee$	$\pi^\star$	$\vee$	$\pi_U^\star$
	$m^\star$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

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
  - General model in other paper (ParisTech this afternoon)
- Today 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)

  $\Longrightarrow$ 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"
  - $D^i(\mathbf{p}) = \lambda \left([\rho_i - 1] \left[p_i + \sum_{j \neq i} \beta_{ji} p_j - \tilde{p}_i \right] \right)^{\frac{\rho_i}{1-\rho_i}}$
  - 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

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 $\Longrightarrow$ 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

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...

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 oligopoly with higher dimension or structure
2. Structural recovery from observable
3. Second-order quantity data
4. Discrete choice log-curvature tests
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 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

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
    - Using product characteristics, income distributions
    - Vertical diff., 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?

Important direct extensions

1. Non-symmetric multi-product models
2. More general connection to discrete choice/empirical IO
   - Vertical differentiation
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?