Generic Pharmaceutical Markets

- US Price: Daraprim: $750 - 1 Mfg
- UK Price: Daraprim: $10 - 1 Mfg
- US Price Gabapentin: $0.17 - 20 Mfg
- UK Price Gabapentin: $0.24 - 11 Mfg
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According to drugs.com

- **Manufacturer**: ACI HEALTHCARE LTD. Approval date: May 14, 2018.
- **Manufacturer**: ACTAVIS ELIZABETH. Approval date: September 12, 2003.
- **Manufacturer**: ALKEM.
- **Manufacturer**: AMNEAL PHARMS NY.
- **Manufacturer**: APOTEX INC.
- **Manufacturer**: AUROBINDO PHARMA LTD.
- **Manufacturer**: EPIC PHARMA LLC.
- **Manufacturer**: INVAGEN PHARMS.

More items...

**Generic Neurontin Availability - Drugs.com**
https://www.drugs.com/availability/generic-neurontin.html
Two questions

**Economic Question:** Why does the law of one price not hold?
Two questions

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» Possible reasons:
  ■ Trade Barriers?
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    • Fixed Cost?

» Policy Question: Why are only some drugs so expensive in the USA?

2% of US GDP // 1% of UK GDP (OECD 2017)

But low US prices for many popular generics/OTC medications
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Q1. What is the role played by fixed entry costs (effectively non-tariff entry barriers)?
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- Matters for trade, antitrust, and competitive law
- Pharma: large issue in new trade agreements
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  » Role of potential market size (Big vs small markets)

Q2. What is the role played by buyer/government bargaining?

  » What is the role of downstream monopsony?
Literature

» Health care competition & price dispersion: Cooper et al. (2018), Craig et al. (2018), Ho and Lee (2017)
  - Pharma: Berndt et al., 2017; Gupta et al., 2018; Grabowski and Vernon, 1992, 1996; Bollyky and Kesselheim, 2017; Reiffen and Ward, 2005; Danzon and Chao, 2000; Danzon and Furukawa, 2003, 2011; Wagner and McCarthy, 2004

  - In Pharma (parallel imports): Malueg and Schwartz, 1994; Ganslandt and Maskus, 2004; Grossman and Lai, 2008; Dubois and Saethre, 2018


Data

- Pharmaceuticals are nearly identical worldwide, but safety/language issues
  - Look only at rich English-speaking countries
Data

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» Role of innovation?
  ■ Only look at off-patent drugs in shelf-stable pill/capsules
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» But! Many prices:
  ■ Wholesale before lump-sum rebates (E.g. from IMS Health)
  ■ Buyer co-pays
  ■ Drug plan premiums
What is a price?

» **This paper**: Per-pill price, net of all rebates, discounts, and pharmacy dispensing fees, paid by end users **and** their government

- US Medicaid, UK NHS, AU PBS, NZ Pharmac, BC PharmaCare, ON Ontario Drug Benefit
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- US Medicaid, UK NHS, AU PBS, NZ Pharmac, BC PharmaCare, ON Ontario Drug Benefit

» Robustness:
  - Medicare Part D (Not inclusive of two-part pricing/rebates/discounts)
  - NADAC Wholesale price (Not inclusive of two-part pricing/rebates/discounts)
Data

- Data is made comparable across all countries
- Unit of observation: Molecule - Dose - Form
Data

» Data is made comparable across all countries

» Unit of observation: Molecule - Dose - Form

» Key innovation:
   ■ Actually use public data! (No expensive, non-transparent private data)
   ■ Link data on consumption, prices, and number of approved manufacturers

» Lots of data work (thank you RAs/co-authors!)
<table>
<thead>
<tr>
<th>Molecule</th>
<th>Dose</th>
<th>Form</th>
<th>Approval</th>
<th>US Mfg</th>
<th>Medicaid $p$</th>
<th>BC $p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>pyrimethamine</td>
<td>25</td>
<td>tablet</td>
<td>1953</td>
<td>1</td>
<td>605.51</td>
<td>1.43</td>
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<td>capsule</td>
<td>1970</td>
<td>1</td>
<td>224.24</td>
<td>3.89</td>
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<td>tablet</td>
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<td>1</td>
<td>90.04</td>
<td>0.68</td>
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<td>capsule</td>
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<td>capsule</td>
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<td>32</td>
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<td>1926</td>
<td>1</td>
<td>37.20</td>
<td>11.49</td>
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<tr>
<td>ethacrynic acid</td>
<td>25</td>
<td>tablet</td>
<td>1967</td>
<td>2</td>
<td>18.46</td>
<td>0.97</td>
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</table>
Summary: Medicaid Comparison

<table>
<thead>
<tr>
<th>Comparison</th>
<th>Obs</th>
<th>Start Year</th>
<th>End Year</th>
<th>Raw log ($P_{US}/P_{Dest}$) Mean</th>
<th>Std. dev.</th>
<th>Mean First FDA Approval</th>
<th>Mean # US Mfgs</th>
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</thead>
<tbody>
<tr>
<td>AU</td>
<td>1706</td>
<td>2008</td>
<td>2017</td>
<td>1.139</td>
<td>1.195</td>
<td>1980</td>
<td>4.25</td>
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<tr>
<td>BC</td>
<td>858</td>
<td>2015</td>
<td>2017</td>
<td>0.735</td>
<td>1.314</td>
<td>1983</td>
<td>4.30</td>
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<tr>
<td>NZ</td>
<td>1470</td>
<td>2009</td>
<td>2017</td>
<td>1.090</td>
<td>1.033</td>
<td>1982</td>
<td>4.23</td>
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<tr>
<td>ON</td>
<td>344</td>
<td>2017</td>
<td>2017</td>
<td>0.886</td>
<td>1.110</td>
<td>1984</td>
<td>4.88</td>
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<tr>
<td>UK</td>
<td>1625</td>
<td>2010</td>
<td>2017</td>
<td>0.899</td>
<td>1.321</td>
<td>1981</td>
<td>4.17</td>
</tr>
</tbody>
</table>
Key Fact: US prices are high in markets with low competition
Motivating Fact: Generic drug demand is inelastic

» Largely inelastic when prescribers and patients do not shoulder the full cost.
  ■ US Medicare, Most foreign systems
Motivating Fact: Generic drug demand is inelastic

» Largely inelastic when prescribers and patients do not shoulder the full cost.
  ■ US Medicare, Most foreign systems

» What about Medicaid, which has minimal cost sharing?

\[ \Delta_y \ln Q_{dyUS} = \Delta_y \ln P_{dyUS} + \delta_y + \epsilon_{dyUS} \]

■ Classic issue: prices are endogenous
■ Very large price changes (>75% within 12 months) Details
  • Usually due to ownership changes (Motivated by pyrimethamine)
■ Exchange rate shocks: Details
  • Most US generics are manufactured abroad
  • Assumption: Exchange rate shocks are purely supply side.
Pricing Model

» Key elements:
  ■ Role of supplier competition, downstream buyer, market size
  ■ Competition between branded and non-branded medications

Past literature: uses

\[ p_{\text{ex}} - \text{manufacturer} = \mu_{\text{manufacturer}} \times \text{mc} \]

without accounting for either ex-ante or ex-post lump-sum payments.

Our starting point:

\[ p = \mu_{\text{value chain}} \times \text{mc} \]

What matters for welfare - is final price, not some intermediate price.
Pricing Model

» Key elements:
  ■ Role of supplier competition, downstream buyer, market size
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» Desires:
  ■ Simplicity (IO weakness)
  ■ Flexible (Medical literature weakness)
Pricing Model

» Key elements:
  ■ Role of supplier competition, downstream buyer, market size
  ■ Competition between branded and non-branded medications

» Desires:
  ■ Simplicity (IO weakness)
  ■ Flexible (Medical literature weakness)

» Reality:

\[ p = \mu_{pharmacy} \times \mu_{PBM} \times \mu_{wholesaler} \times \mu_{manufacturer} \times mc \]

■ Past literature: uses \( p_{ex-manufacturer} = \mu_{manufacturer} \times mc \) without accounting for either ex-ante or ex-post lump-sum payments.

» Our starting point:

\[ p = \mu_{value\ chain} \times mc \]

■ What matters for welfare - is final price, not some intermediate price.
Two-Period Game

1. Generic suppliers choose to enter the market. Pay fixed costs (includes regulatory costs, as well as bi-lateral payments to PBMs, pharmacies, doctors, and wholesalers)

\[ \pi_{f,d}(s; S) \geq F_f. \]

\( \pi_{f,d}(s; S) \): profit of the marginal \( s^{th} \) supplier

1.1 Assume entry costs independent between markets, with an unlimited number of potential (mostly Indian/Chinese) entrants

ex: there are 62 Pyrimethamine suppliers on Alibaba/10 on Trade India

2. Suppliers (after all payments), negotiate final price with final buyer

\[ \pi_{f,d}(s; S) = \mu_{f,d}(s; S) \times c_{f,d} \times q_{f,d}(s; S). \]

2.1 Will be agnostic on the type of competition

3. Sales are made

- Most public plans have inelastic demand - shown with exchange rate shocks
How prices are determined: Monopolist seller and monopolist buyer

» Nash surplus between seller $s$ and buyer $b$

\[ NS = (pq - cq)^{w_s} (\bar{p}_b q - pq)^{1-w_s} , \]

- $\bar{p}_b$: Choke price
  - acquisition price if negotiations break down
  - includes political risk
How prices are determined: Monopolist seller and monopolist buyer

» Nash surplus between seller \( s \) and buyer \( b \)

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NS = (pq - cq)^{w_s} (\bar{p}q - pq)^{1-w_s},
\]

- \( \bar{p}_b \): Choke price
  - acquisition price if negotiations break down
  - includes political risk

» First order conditions imply:

\[
 p_m = w_s \bar{p} + (1 - w_s) c. \tag{1}
\]

» If \( w_s = 0 \), essentially perfect competition:

\[
 p_c = c \tag{2}
\]

If \( w_b = 0 \), monopolist choke price:

\[
 p_m = \bar{p}_b \tag{3}
\]
Generalization

» What if there is more than one upstream seller?
» How to account for upstream market power?

- Competition function:

$$\theta(S) : \mathbb{I}^+ \rightarrow \mathbb{R} \in [0, 1]$$

- Maps the number of competitors between monopoly and perfect competition
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■ Weights between the Nash solution and perfect competition:

\[ p = \theta (S) p_m + (1 - \theta (S)) c \] (4)
Generalization

» What if there is more than one upstream seller?
» How to account for upstream market power?
  ■ Competition function:

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\theta (S) : \mathbb{N}^+ \to \mathbb{R} \in [0, 1]
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  • Maps the number of competitors between monopoly and perfect competition

■ Weights between the Nash solution and perfect competition:

\[
p = \theta (S) p_m + (1 - \theta (S)) c
\]

(4)

» Extensions to Bertrand, Discrete choice, Multiple buyers, Repeated game

» Intuition: Conditional on the number of entrants, pricing is fully determined.

» Assume that the choke price \( \bar{p} \) is a multiplicative function of the marginal cost:

\[
\bar{p} = \gamma_b c
\]

» Parameterize competition:

\[
\theta (S) = \exp (\alpha \log S)
\]

» Define a buyer-specific leverage parameter \( \kappa_b \):
Role of market size

» Excess Profits: $\Pi$
  ■ Under constant marginal costs, how much more operating profit is required to enter a particular country to cover fixed entry costs?
Role of market size

» Excess Profits: \( \Pi \)
  - Under constant marginal costs, how much more operating profit is required to enter a particular country to cover fixed entry costs?

» How much more does it cost to enter the US, than other markets?
  - Data for market size in US, UK, AU
Role of market size

» Recover fixed cost differences between two markets:

\[ \Pi_{excess} = \Pi^U (S_U) - \Pi^{Foreign} (S_{Foreign}) \quad (5) \]

- Only done for the marginal generic entrant (as opposed to an incumbent brand)
Role of market size

» Recover fixed cost differences between two markets:

\[ \Pi_{excess} = \Pi^U_S(S_{US}) - \Pi^F_{Foreign}(S_{Foreign}) \]  \hspace{1cm} (5)

- Only done for the marginal generic entrant (as opposed to an incumbent brand)

» Bound how many more entrants the US ‘could’ support:

\[ \Pi_{excess}(S^*_{US}) \geq 0 \]

» Intuition: Revealed preference + backward induction.
Estimates for $\alpha$ and $\kappa$

<table>
<thead>
<tr>
<th></th>
<th>Medicaid Molecule-Dose</th>
<th>Medicare(d) Molecule</th>
<th>NADAC Molecule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competition $\alpha$</td>
<td>-1.18 (0.08)</td>
<td>-1.43 (0.14)</td>
<td>-1.25 (0.19)</td>
</tr>
<tr>
<td>Bargaining US</td>
<td>5.50 (0.38)</td>
<td>6.38 (0.95)</td>
<td>5.87 (0.60)</td>
</tr>
<tr>
<td>Bargaining AU</td>
<td>1.00 (0.00)</td>
<td>1.02 (0.06)</td>
<td>1.00 (0.00)</td>
</tr>
<tr>
<td>Bargaining BC</td>
<td>1.00 (0.00)</td>
<td>1.00 (0.02)</td>
<td>1.00 (0.00)</td>
</tr>
<tr>
<td>Bargaining NZ</td>
<td>1.73 (0.08)</td>
<td>1.18 (0.15)</td>
<td>1.02 (0.08)</td>
</tr>
<tr>
<td>Bargaining ON</td>
<td>1.09 (0.19)</td>
<td>1.00 (0.09)</td>
<td>1.11 (0.24)</td>
</tr>
<tr>
<td>Bargaining UK</td>
<td>1.66 (0.17)</td>
<td>1.75 (0.26)</td>
<td>1.81 (0.19)</td>
</tr>
</tbody>
</table>

Unbounded estimates: [details](#)
## Excess Entry Cost Estimates

<table>
<thead>
<tr>
<th>scenario/est ($M)</th>
<th>Medicaid Molecule-Dose</th>
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<tbody>
<tr>
<td>AU</td>
<td>13.68 (0.42)</td>
<td>9.54 (1.20)</td>
<td>5.65 (1.26)</td>
</tr>
<tr>
<td>UK</td>
<td>7.94 (0.38)</td>
<td>8.00 (1.12)</td>
<td>7.11 (1.14)</td>
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</tbody>
</table>

Unbounded estimates: [details](#)
Counterfactuals

» Questions:

- What is the role of market barriers in price dispersion?
- What is the role of downstream buyer leverage (combining market power and bargaining weights)?
Counterfactuals

» Questions:
  ■ What is the role of market barriers in price dispersion?
  ■ What is the role of downstream buyer leverage (combining market power and bargaining weights)?

» Four counterfactuals
  ■ Different permutations of policies.
Counterfactual 1: Single Market

» Lots of variation in number of sellers.
» Simple idea: if profitable in one, then allow entry in all markets.
Counterfactual 1: Single Market

» Lots of variation in number of sellers.
» Simple idea: if profitable in one, then allow entry in all markets.

» Current FDA proposal.

<table>
<thead>
<tr>
<th>Cost Saving(%)</th>
<th>Medicaid Molecule-Dose</th>
<th>Medicare(d) Molecule</th>
<th>NADAC/Medicaid Molecule</th>
</tr>
</thead>
<tbody>
<tr>
<td>CF 1: Single Market</td>
<td>-7.8 (-0.7)</td>
<td>-2.9 (-0.4)</td>
<td>-3.8 (-0.8)</td>
</tr>
</tbody>
</table>
Counterfactual 2: Strong US Buyer Leverage (Bargaining)

» What if the USA bargaining was an average of the rest of the English speaking world?
» ii.e. Suppose Medicaid had the same leverage as the NHS/Pharmac/Etc?
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» What if the USA bargaining was an average of the rest of the English speaking world?
» ii.e. Suppose Medicaid had the same leverage as the NHS/Pharmac/Etc?

» Effectively a “take-it-or-leave-it” offer

<table>
<thead>
<tr>
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<tr>
<td>CF 2: Bargaining</td>
<td>-18.3 (-4.1)</td>
<td>-12.3 (-3.5)</td>
<td>-20.8 (-8.3)</td>
</tr>
</tbody>
</table>

Ganapati+McKibbin 23
Counterfactual 3: Both Single Market and US Buyer Leverage

» Do both?
» Limited in the sense that with perfect buyer leverage - no need to allow entry
Counterfactual 3: Both Single Market and US Buyer Leverage

» Do both?
» Limited in the sense that with perfect buyer leverage - no need to allow entry

» Results similar to better buyer leverage

<table>
<thead>
<tr>
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<td>CF 2: Bargaining</td>
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<td>-20.8 (-8.3)</td>
</tr>
<tr>
<td>CF 3: Both</td>
<td>-18.6 (-4.1)</td>
<td>-12.4 (-3.5)</td>
<td>-21.0 (-8.3)</td>
</tr>
</tbody>
</table>
Counterfactual 4: Elimination of Excess Entry Costs

» CF 1: Didn’t allow new market entry. If US fixed entry costs were in line with ROW, what would happen?
» Caveat: We don’t have data on the entire world. Manufacturing fixed costs could now play a role.
Counterfactual 4: Elimination of Excess Entry Costs

» CF 1: Didn’t allow new market entry. If US fixed entry costs were in line with ROW, what would happen?
» Caveat: We don’t have data on the entire world. Manufacturing fixed costs could now play a role.

» View this as upper bound on market entry:

<table>
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<tr>
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<tr>
<td>CF 1: Single Market</td>
<td>-7.8 (-0.7)</td>
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<td>CF 3: Both</td>
<td>-18.6 (-4.1)</td>
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<td>-21.0 (-8.3)</td>
</tr>
<tr>
<td>CF 4: Free Entry</td>
<td>-16.0 (-2.2)</td>
<td>-8.9 (-2.0)</td>
<td>-6.1 (-0.7)</td>
</tr>
</tbody>
</table>
What about the average drug?

» These results are heavily weighted by “blockbuster” drugs.
  ■ Generic Lipitor, Xanax, etc..
What about the average drug?

» These results are heavily weighted by “blockbuster” drugs.

■ Generic Lipitor, Xanax, etc..

» But what about the ’average’ drug?

<table>
<thead>
<tr>
<th>scenario/est (%)</th>
<th>Medicaid Molecule-Dose</th>
<th>Medicare(d) Molecule</th>
<th>NADAC/Medicaid Molecule</th>
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</thead>
<tbody>
<tr>
<td>CF 1: Single Market</td>
<td>-10.6 (-0.3)</td>
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<td>-6.1 (-0.4)</td>
</tr>
<tr>
<td>CF 2: Leverage</td>
<td>-33.3 (-3.4)</td>
<td>-29.2 (-4.0)</td>
<td>-39.1 (-7.5)</td>
</tr>
<tr>
<td>CF 3: Both</td>
<td>-33.8 (-3.4)</td>
<td>-29.4 (-4.0)</td>
<td>-39.4 (-7.5)</td>
</tr>
<tr>
<td>CF 4: Free Entry</td>
<td>-32.4 (-2.2)</td>
<td>-25.7 (-3.0)</td>
<td>-17.0 (-0.7)</td>
</tr>
</tbody>
</table>
Conclusion

» Use generics to isolate market away from the role of innovation
» Understand the effects of competition and buyer leverage
  ■ leverage = combination of downstream market power and bargaining
» Find substantial cost savings (up to 20%)
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» Next steps:
   ■ Can we take this model and reintroduce the role of innovation for on-patent drugs?
Thank You!
Motivating Fact: Generic drug demand is inelastic (Price Jumps)

In counterfactuals - will fix drug demand exogenously.

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>D.log(q)</td>
<td>D2.log(q)</td>
<td>D3.log(q)</td>
<td>D4.log(q)</td>
</tr>
<tr>
<td>Log Price Change</td>
<td>-0.00398</td>
<td>-0.0371</td>
<td>-0.0246</td>
<td>-0.0189</td>
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<tr>
<td></td>
<td>(0.00638)</td>
<td>(0.0271)</td>
<td>(0.0334)</td>
<td>(0.0369)</td>
</tr>
<tr>
<td>Observations</td>
<td>1081</td>
<td>1886</td>
<td>1430</td>
<td>1081</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.015</td>
<td>0.077</td>
<td>0.044</td>
<td>0.022</td>
</tr>
<tr>
<td>FE</td>
<td>year</td>
<td>year</td>
<td>year</td>
<td>year</td>
</tr>
</tbody>
</table>
Motivating Fact: Generic drug demand is inelastic (Exchange Rates)

<table>
<thead>
<tr>
<th></th>
<th>(1) Least Squares</th>
<th>(2) First Stage</th>
<th>(3) Instrumental Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>D.In(P)</td>
<td>-0.0308*</td>
<td></td>
<td>0.337</td>
</tr>
<tr>
<td></td>
<td>(0.0134)</td>
<td></td>
<td>(0.182)</td>
</tr>
<tr>
<td>ln(Expected Price Change)</td>
<td></td>
<td>0.0515***</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.00799)</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>5556</td>
<td>5556</td>
<td>5556</td>
</tr>
<tr>
<td>FE</td>
<td>Year</td>
<td>Year</td>
<td>Year</td>
</tr>
<tr>
<td>F-stat</td>
<td>5.281</td>
<td>41.60</td>
<td>3.402</td>
</tr>
</tbody>
</table>

» In counterfactuals - will fix drug demand exogenously.
## Unbounded Estimates for $\alpha$ and $\kappa$

<table>
<thead>
<tr>
<th></th>
<th>Medicaid Molecule-Dose</th>
<th>Medicaid(d) Molecule</th>
<th>Medicare(d) Molecule</th>
<th>NADAC Molecule</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Competition $\alpha$</strong></td>
<td>-1.12 (0.09)</td>
<td>-1.64 (0.23)</td>
<td>-1.41 (0.12)</td>
<td>-1.12 (0.25)</td>
</tr>
<tr>
<td><strong>Bargaining US</strong></td>
<td>5.14 (0.36)</td>
<td>3.98 (0.31)</td>
<td>6.18 (0.67)</td>
<td>5.26 (1.81)</td>
</tr>
<tr>
<td><strong>Bargaining AU</strong></td>
<td>0.85 (0.04)</td>
<td>0.77 (0.06)</td>
<td>1.01 (0.12)</td>
<td>0.75 (0.09)</td>
</tr>
<tr>
<td><strong>Bargaining BC</strong></td>
<td>0.57 (0.07)</td>
<td>0.51 (0.08)</td>
<td>0.67 (0.14)</td>
<td>0.63 (0.10)</td>
</tr>
<tr>
<td><strong>Bargaining NZ</strong></td>
<td>1.68 (0.08)</td>
<td>1.15 (0.09)</td>
<td>1.17 (0.11)</td>
<td>0.98 (0.13)</td>
</tr>
<tr>
<td><strong>Bargaining ON</strong></td>
<td>1.04 (0.22)</td>
<td>0.74 (0.16)</td>
<td>0.94 (0.28)</td>
<td>1.05 (0.25)</td>
</tr>
<tr>
<td><strong>Bargaining UK</strong></td>
<td>1.64 (0.17)</td>
<td>1.61 (0.17)</td>
<td>1.73 (0.34)</td>
<td>1.75 (0.28)</td>
</tr>
</tbody>
</table>

Return to [bounded estimates](#)
Unbounded Excess Entry Cost Estimates

<table>
<thead>
<tr>
<th>scenario/est ($M)</th>
<th>Medicaid Molecule-Dose</th>
<th>Medicaid(d) Molecule</th>
<th>Medicare(d) Molecule</th>
<th>NADAC Molecule</th>
</tr>
</thead>
<tbody>
<tr>
<td>AU</td>
<td>15.47</td>
<td>10.04</td>
<td>11.00</td>
<td>7.76</td>
</tr>
<tr>
<td></td>
<td>(6.68)</td>
<td>(10.39)</td>
<td>(19.79)</td>
<td>(40.06)</td>
</tr>
<tr>
<td>UK</td>
<td>8.11</td>
<td>9.06</td>
<td>9.07</td>
<td>8.07</td>
</tr>
<tr>
<td></td>
<td>(4.59)</td>
<td>(9.04)</td>
<td>(13.81)</td>
<td>(33.68)</td>
</tr>
</tbody>
</table>

Return to bounded estimates
Aside: Bertrand

\[ \theta(S) = \begin{cases} 
1 & S = 1 \\
0 & S \geq 2.
\end{cases} \]
Aside: Discrete Choice

\[ \theta(S) = \frac{1}{\alpha \left(1 - \frac{1}{S}\right)} \times \frac{1}{p_m - p_c} \]
Aside: Multiple Buyers

» Rationalize this in a Nash-in-Nash setup
  ■ Simplification: if segmented markets, allow for variation in $w_s$

Return to Return
Estimation

GMM estimation for $\alpha, \kappa, c_r$:

\[ E \left( \log \frac{p_{b1}}{p_{b2}} - \log \hat{p} (\alpha, \kappa, c_r) \right) = 0 \]

\[ C = M (\alpha, \kappa, c_r) W M (\alpha, \kappa, c_r)' \]
Estimation

GMM estimation for $\alpha, \kappa, c_r$:

$$E \left( \log \frac{p_{b1}}{p_{b2}} - \log \hat{p} (\alpha, \kappa, c_r) \right) = 0$$

$$C = M (\alpha, \kappa, c_r) WM (\alpha, \kappa, c_r)'$$

Bound estimation for fixed entry costs:

$$\Pi_{ excess} (S_{US}^*) > 0$$
Identification - Common Drugs

» Average cost difference between countries at perfect competition:

\[ \frac{p_1}{p_2} \rightarrow S_{b1}, S_{b2} \rightarrow \infty \quad \frac{c_1}{c_2} = c_{1/2} \]

Identifies \( c_{1/2} \)
Identification - Common Drugs

» Average cost difference between countries at perfect competition:

\[
\frac{p_1}{p_2} \to S_{b1}, S_{b2} \to \infty \quad \frac{c_1}{c_2} = \frac{c_1}{2}
\]

Identifies \( c_{1/2} \)

» Real world identification:

- Extremely common heart and diabetes medication
- Dozens of entrants \( \to \) identifies levels of marginal cost differences
Identification - Variation in Entrants

Using variation in number of competitors between countries:

\[
\frac{p_1}{p_2} \rightarrow S_1 = 1, S_2 \rightarrow \infty \quad \frac{\kappa_1}{1} c_{1/2}
\]

Identifies \( \kappa_1, \kappa_2 \)
Identification - Variation in Entrants

» Using variation in number of competitors between countries:

\[
\frac{p_1}{p_2} \rightarrow S_1 = 1, S_2 \rightarrow \infty \quad \frac{\kappa_1}{1} c_{1/2}
\]

Identifies \( \kappa_1, \kappa_2 \)

» Real world identification:

- Some drugs have more entrants in different countries
- Driven by unobservable difference in drug demand (i.e. Australia has relatively higher demand for anti-malaria medication than Canada)
Identification - Intermediate Price Differences

» Price variation according to the number of competitors:

\[ \frac{p_1}{p_2} = \exp(\alpha \log S_1) + 1. \]

Identifies \( \alpha \)
Identification - Intermediate Price Differences

» Price variation according to the number of competitors:

\[ \frac{p_1}{p_2} = \exp (\alpha \log S_1) + 1. \]

Identifies \( \alpha \)

» Real world identification

- Suppose we net out the role of \( \kappa \) and \( \alpha \)
- High relative US prices when there are few entrants
- Only identified when bargaining parameter significantly different from perfect competition