# THE DETERMINANTS OF PRICING IN PHARMACEUTICAL: ARE U.S. PRICES REALLY HIGHER THAN THOSE IN CANADA?

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# Introduction (I)

- Theoretical reasons for interventions in pharmaceutics (barriers to entry, insurance, prescriptions).
- Ballance et al. (1992) find most countries impose some price controls - with variation.
- Scherer (2000): reference pricing, product per product negotiation, price caps, rate of return regulation and formula pricing.
- Regulation can also be used to shift rents (national champions, consumer/voters-particularly for non-national firms).
  - Indeed “Low regulators” tend to have powerful industries (US, Germany, UK, Switzerland), , but with exceptions (France, Japan).
- Besides regulation, other factors (industry structure, quality).

# Introduction (II): Regulation, innovation and prices

- the low marginal costs are an inducement for countries, especially those with a single provider of health services, to drive a hard bargain with the companies in order to achieve a politically expedient low price.

  $\Longrightarrow$ innovation may go down if all countries do something like that, but the effect of a single country, especially a small one, on total innovation would be negligible.

  In this sense Light and Lexchin (2005) have argued: *The United States government is engaged in a campaign to characterise other industrialised countries as free riding on high US pharmaceutical prices and innovation in new drugs. This campaign is based on the argument that lower prices imposed by price controls in other affluent countries do not pay for research and development costs, so that Americans have to pay the research costs through higher prices in order to keep supplying the world with new drugs.*

- Regulation can also be used to shift rents (national champions, consumer/voters-particularly for non-national firms).

# Introduction (III): literature

- ⋆ Regulation:
  - ○ Danzon and Chao (2000a): regulation bad when there is competition.
  - ○ Danzon and Chao (2000b): In a very restricted dataset and after an strong homogeneization effort they find that U.S. prices not so large - previous work sloppy.
  - ○ U.S. Department of Commerce (2004): lower prices by regulation implies less products
  - ○ Domínguez, Ganuza and Llobet (2006): ambiguous effect on innovation (hurts me-too more).
  - ○ Kyle (2005): effect of price controls in extent and timing of the launch of new drugs.
- ⋆ Specification
  - ○ Berndt et al (1999): marginal costs irrelevant - thus hedonic prices.
  - ○ Ambiguous effects of generics on prices (Grabowski and Vernon, 1992 and 1997, and Caves, Whinston and Hurwitz 1991, Wiggins and Maness, 1994).
  - ○ Frank and Salkever (1992 and 1997): number of competitors effect unstable.

# Introduction (IV): Main questions of interest (for today's talk)

- ¿Are pharma prices higher in the US than in other developed countries?

  Ex-ante the response seems to be yes, however:

  - The US is typically the richest country in the samples used for cross-country comparisons: Under Ramsey pricing, a profit-maximizing firm (as well as any social welfare maximizer) would sell at different prices in different countries.
  - Thus, average prices which varied with the income elasticity of demand could be consistent with a benign form of regulation which would not necessarily hurt innovation.

- ¿Does nationality matters in price determination? ¿ Are local firms (specially those multinationals) better treated than foreign multinational firms?

  - A politico-economic logic also suggests that a free-riding regulator would treat local companies better than foreign ones, as the welfare of local shareholders enters more strongly in the objective function of the regulators. Thus, the treatment of foreign vs. local firms could be a more telling smoking gun than pure-average variation in prices across countries.

# Introduction (V): data

- Despite interest, little systematic study
  - Lu and Comanor 1998, Danzon and Chao 2000a, 2000b, Ekelund and Persson 2003-few countries or products.
  - New line on launch and regulation developing very rapidly (Kyle (2007), Danzon (2007)
- We study pricing with comprehensive product list (IMS MIDAS), for 25 countries and yearly 1998-2003.
- 10 largest countries and another 15 (smaller and/or poorer).
- Rich data allows to study determinants across countries, regulatory regimes and industrial structure.

# Introduction (VI): empirical strategy

- Separate pricing equation by country and then pooled.
- Pooling allows to explore cross-national variables (GDP, Gov/GDP).
- Exploit the panel nature of the data and control for unobserved heterogeneity.
  1. This reduces variation: for time-invariant variables two-stage procedure.
- No sample restrictions. For robustness check restrictions to:
  1. Single molecule products.
  2. The variation with number of countries corporation is present (innovation dimension).
  3. The variation with number of countries a molecule is present (diffusion dimension).
  4. The analysis by therapeutical category.

# Index of the presentation

# The model

- ⋆ Model for (political economy) price setting: Demands at Home ($H$) and Foreign ($F$)

$$\log Q_H = A_H - b \log p_H;\ \log Q_F = A_F - b \log p_F$$

- ⋆ $H$ policy: $p_H \leq \overline{p}_H$ or no sale in $H$. $F$ policy: reference price, $p_F \leq p_H$.
- ⋆ Determination of $\overline{p}_H$
- ⋆ If company has headquarters in $H$,

$$\max_p A_H \frac{p^{1-\beta}}{\beta-1} + \left(A_H p^{-\beta} + A_F p^{-\beta}\right)(p-c) \text{ s.a. } \left(A_H p^{-\beta} + A_F p^{-\beta}\right)(p-c) \geq \pi_F^*$$

  $\pi_F^*$ is monopoly profit of selling only at $F$.

- ⋆ If the headquarters at $F$, then:

$$\max_p A_H \frac{p^{1-\beta}}{\beta-1} \qquad \text{s.a. } \left(A_H p^{-\beta} + A_F p^{-\beta}\right)(p-c) \geq \pi_F^*$$

- ⋆ Solution: Model predicts price weakly higher for the local multinational.
  As $\lambda = A_F/(A_F + A_H)$ grows ($F$ is sufficiently larger/richer), constraint binds.
- ⋆ **Conclusion**: As size of $F$ grows with respect to $H$, the price of the foreign multinational converges to that of the local multinational (V.I. WHEN H IS THE US).

# Econometric specification (I)

- ⋆ Equilibrium price for product $i$ of firm $f$ in market $k$ and country $j$, $p^{'}_{ifkj}$
- ⋆ We consider the following log-linear specification:

$$\log(p^{'}_{ifkjt}) = \alpha + A^{*}_{ifkjt} + v_{ifkjt}$$

where $t$ denotes time, $v$ an error term, and $\alpha$ a parameter.

- ⋆ We further consider

$$A^{*}_{ifkjt} = X'_{ifkjt}\beta + Z'_{i}\gamma + \eta_r + \eta_j + d_t$$

$X$ and $Z$ vectors of time-variant and time-invariant variables, $\eta_r$ represents a specific effect ($r$ is $i, f, \text{or}, k$), and $d_t$ is a time specific factor. Then:

$$\log(p^{'}_{ifkjt}) = \alpha + X'_{ifkjt}\beta + Z'_{i}\gamma + \eta_r + \eta_j + d_t + v_{ifkjt} \qquad (1)$$

- ⋆ When $r = i$, the effect of $Z_i$ absorbed by the individual effects and, not directly identifiable.

# Econometric specification (II)

- ⋆ Instead we follow a two-stage procedure to estimate them (Mundlak, 1978):
  - ○ First estimate the above equation and obtain an estimate of $\eta_i$, say $\hat{\eta}_i$,
  - ○ Then we regress $\hat{\eta}_i$ against the time invariant factors:

$$\hat{\eta}_i = Z_i'\gamma + \eta_j + \eta_f + \eta_k + u_i \qquad (2)$$

  $u_i$ is an error term and $\eta_k$ and $\eta_f$ control for market (or molecule) and firm specific effects.

- ⋆ If we assume random and uncorrelated with $Z$, LS estimate suffices.
- ⋆ Alternatively, use LSDV estimator controlling either $\eta_k$, $\eta_f$ or both.
- ⋆ We estimate equations (1 and 2) using a Within Groups panel data method.
  - ○ In first stage, we control for time-invariant heterogeneity across products.
  - ○ In second, we control for heterogeneity across molecules.
- ⋆ In order to avoid endogeneity problems, we follow an IV approach: all the time-varying covariates lagged.

# Data and variables (I)

- 25 countries: Top ten by expenditure, as well as medium size and small/poor countries.
- We carry the analysis at the country level (25 countries) and pooling the data for all the countries.
- Multi-country and multi (all?)-product data set from the IMS MIDAS 1998-2003
- Large number of groups or anatomic classifications: We regard (ATC4) as a market.
- **Variables**
- *Price* (dependent variable): sales revenue divided by number of 'standard units' sold.
- Variables relative to quality and competition:
  - 1st stage: Fsize, Globalprice, new, ngen, HHI, Mshare, Natshare, Berry index.
  - 2nd stage: Fquota, singlemol, Molage, Censormol, censorlag, censormol.
  - Dummy controlling the nationality of the firm: local, local-multinational and multinational (interacted with Fquota, Mshare and New).
- Log transformations of *Price*, *Fsize*, *Globalprice Molage*, and *Summol*.

# Specification issues and robustness checks in pooled regressions (II)

- In the 1st stage pooled countries regression we additionally control for:
  - *FPC*: Fraction of public consumption in GDP.
  - *GDPPCUSD*: GDP per capita in 2000 US$.
  - Both of them are interacted with a set (three levels) of regulatory dummies.
    1. Australia, Czech Republic, Canada, Denmark, Finland, Germany, Hungary, The Netherlands, Norway, Poland, Sweden, Switzerland, UK and the US.
    2. Austria, Belgium, France, Japan, Greece, Portugal, Spain.
    3. Argentina, Brazil, Egypt, Italy, Portugal.
- In the pooled joint analysis we check robustness in several dimensions:
  - Number of countries in which corporation to which product belongs is present
  - Number of countries in which a given molecule is present.
  - Also restricting the sample to single molecules, and products for which molecule and corporation present in all countries.
  - We repeat the analysis by therapeutical class.

# Country by country results (I): results for selected countries

| | ita | fra | jap | spa | can | ger | uk | us |
|---|---|---|---|---|---|---|---|---|
| 1st stage price equation results including product fixed effects | | | | | | | | |
| new1 | 0.015 | 0.010 | 0.015 | 0.018* | -0.009 | 0.016** | 0.010 | 0.085** |
| new1*local | 0.091 | 0.117 | -0.050 | 0.129* | -0.018 | 0.090* | 0.072 | 0.204** |
| new1*localm | 0.013 | 0.016 | 0.010 | 0.023** | 0.002 | 0.024** | 0.005 | 0.041** |
| Berry index | 0.060** | 0.037 | 0.096 | -0.017 | 0.036 | 0.002 | -0.011 | 0.021 |
| Ngen | 0.002 | -0.002 | -0.012 | -0.017 | 0.116** | 0.004 | -0.026 | -0.041 |
| global price | -0.007 | 0.003 | 0.028* | 0.003 | -0.011 | -0.003 | 0.046** | 0.007 |
| intercept | 3.891** | 3.141** | 4.117** | 3.461** | 3.181** | 3.300** | 4.172** | 3.307** |
| N | 5759 | 5798 | 5340 | 5074 | 7296 | 17336 | 3072 | 15474 |
| r2-w | 0.347 | 0.340 | 0.287 | 0.373 | 0.051 | 0.217 | 0.159 | 0.045 |
| r2-o | 0.019 | 0.150 | 0.048 | 0.079 | 0.005 | 0.183 | 0.029 | 0.226 |
| 2nd stage regression of the 1st stage average residual | | | | | | | | |
| local | -0.446** | -0.685** | -1.038** | -0.541** | -0.591** | -0.046 | -1.012** | -0.930** |
| localmulti | -0.413* | -0.393** | 0.011 | 0.100 | -0.248 | -0.113 | -0.073 | 0.160 |
| singlemol | 0.684** | -0.145 | -0.295 | 0.280* | 0.382** | 0.246** | 0.439* | 0.502** |
| lsummol | 0.053 | 0.532** | 0.317** | 0.359** | 0.531** | 0.548** | 0.285** | 0.176** |
| generic | -0.388** | -0.908** | -0.252 | -0.382** | 0.402** | -0.689** | -0.999** | -0.524** |
| intercept | 1.230 | 4.586** | 4.933** | 4.683** | 11.147** | 6.958** | 3.958** | 9.178** |
| N | 1680 | 1654 | 1509 | 1475 | 2045 | 4956 | 867 | 4626 |
| r2 | 0.046 | 0.200 | 0.103 | 0.105 | 0.177 | 0.157 | 0.139 | 0.179 |

note: a number of variables are excluded from the presentations

# Country by country results (II)

- 1st stage:
  1. Market share of national products, concentration of local products, and Berry index little effect on prices.
  2. New products get a small premium (largest for the US) - nationality does matter except Italy and Canada.
  3. The effect of firm size in prices is either non-significant or negative but small.
  4. Number of generics in molecule, significantly reduces prices.
  5. Global prices have very little independent effect.

- 2nd stage:
  1. Products from exclusively local corporations have lower prices
  2. The effect of being local multinational is less clear. Many insignificant or negative. But:
     - Countries with significant pharmaceutical industry, local and foreign multinational are treated equally (France excepted).
     - Some significantly negative (France, Italy, and Sweden among others). Still better than exclusively local.
  3. Single molecule effect is in general positive and large, specially in big pharmaceutical markets.
  4. *generic* is typically negative.
  5. The elasticity to the number of markets the molecule is present is large (less large in the US).

# Pooled countries results (I): 1st stage

| | ALL | | CORP 25C | | MOL 25C | | C+M 25C | |
|---|---|---|---|---|---|---|---|---|
| | coef | t-stat | coef | t-stat | coef | t-stat | coef | t-stat |
| Natshare | 0.001 | 0.04 | -0.068 | -2.67 | 0.120 | 1.89 | -0.001 | -0.02 |
| HHI-local | 0.007 | 1.04 | 0.001 | 0.16 | 0.003 | 0.11 | -0.003 | -0.10 |
| fsize1 | -0.013 | -4.92 | -0.011 | -2.48 | -0.014 | -1.52 | -0.016 | -0.98 |
| new1 | 0.005 | 0.91 | 0.029 | 5.11 | 0.025 | 2.14 | 0.051 | 3.48 |
| localnew1 | 0.121 | 10.14 | – | | 0.117 | 4.13 | – | |
| localnewm1 | -0.029 | -1.95 | -0.028 | -1.97 | -0.064 | -2.31 | -0.108 | -4.32 |
| dum-GP n.a. | 0.430 | 17.07 | 0.368 | 9.33 | 0.790 | 5.99 | 0.588 | 4.32 |
| global price | 0.096 | 17.28 | 0.070 | 9.00 | 0.237 | 7.44 | 0.181 | 5.05 |
| Ngen | 0.001 | 0.91 | 0.000 | 0.57 | -0.003 | -1.36 | -0.000 | -0.09 |
| Berry index | 0.006 | 1.56 | 0.012 | 2.15 | 0.018 | 1.29 | 0.018 | 0.93 |
| fpc | 2.004 | 11.23 | 1.825 | 6.93 | 1.229 | 4.12 | 1.345 | 3.52 |
| gdppcusd | 2.008 | 9.42 | 1.078 | 3.28 | 1.427 | 4.47 | 0.808 | 1.93 |
| fpc*reg2 | -0.953 | -3.88 | -0.672 | -1.70 | 0.197 | 0.45 | -0.159 | -0.33 |
| fpc*reg3 | -1.567 | -4.68 | -0.944 | -1.37 | -0.126 | -0.26 | -0.745 | -0.96 |
| gdp*reg2 | 0.407 | 2.68 | 0.562 | 2.66 | 0.755 | 2.44 | 0.839 | 2.06 |
| gdp*reg3 | 1.085 | 4.48 | 1.654 | 4.21 | 2.025 | 4.92 | 2.422 | 4.45 |
| intercept | -0.273 | 3.66 | 2.828 | 3.48 | -0.072 | -0.09 | 1.927 | 1.82 |
| N | 131517 | | 43645 | | 9891 | | 4766 | |
| r2-w | 0.287 | | 0.290 | | 0.367 | | 0.329 | |
| r2-o | 0.044 | | 0.006 | | 0.078 | | 0.008 | |
| F | 237.06 | | 84.08 | | 55.86 | | 39.70 | |

WG-IV estimator with clustered standard errors.

# Pooled countries results (II): 1st stage

- Firm size is significantly negative, but small.
- Number of generics does not have systematic effect.
- New products get a premium, especially for local innovative firms.
- Global price is always positive and significant.
- Fraction of public expenditure in GDP and per capita GDP.
  1. For low regulated countries (REG1): effect of both is positive and significant.
     - Price elasticity to fraction of public expenditures in GDP $\longrightarrow$ 1.2 and 2.0.
     - Price elasticity of the GDP per capita $\longrightarrow$ 0.8 to 2.0
  2. In medium and high regulated countries:
     - Elasticity to fraction of public consumption in the GDP gets reduced.
     - Elasticity to GPD is significantly higher.

# Pooled countries results (III): 2nd stage

| | ALL | | CORP 25C | | MOL 25C | | C+M 25C | |
|---|---|---|---|---|---|---|---|---|
| | coef | t-stat | coef | t-stat | coef | t-stat | coef | t-stat |
| local | -0.163 | -9.33 | – | | -0.146 | -6.83 | – | |
| localmulti | 0.045 | 1.84 | 0.004 | 0.08 | 0.058 | 1.96 | -0.274 | -2.19 |
| molage | -0.103 | -4.13 | -0.056 | -1.79 | -0.080 | -2.84 | -0.020 | -0.34 |
| lsummol | -0.038 | -0.41 | 0.079 | 0.47 | 0.207 | 0.43 | – | |
| censormol | -0.056 | -0.84 | -0.074 | -0.59 | -0.055 | -0.72 | 0.006 | 0.03 |
| censorlag | 0.049 | 0.78 | 0.107 | 0.78 | 0.014 | 0.20 | -0.019 | -0.10 |
| generic | -0.173 | -5.91 | -0.165 | -2.81 | -0.164 | -5.09 | - -0.323 | -4.37 |
| arg | -1.957 | -23.96 | -3.747 | -46.63 | -1.949 | -20.92 | -5.097 | -25.29 |
| bra | -0.266 | -3.16 | -2.426 | -33.72 | -0.260 | -2.93 | -3.686 | -25.14 |
| egy | 0.889 | 7.02 | -1.280 | -12.48 | 1.109 | 7.83 | -1.571 | -6.14 |
| ita | -5.193 | -61.26 | -6.947 | -105.13 | -5.250 | -56.35 | -8.855 | -70.88 |
| aut | -2.840 | -42.23 | -3.704 | -55.51 | -2.456 | -33.16 | -3.578 | -17.33 |
| bel | -2.834 | -37.32 | -3.693 | -51.75 | -2.483 | -29.41 | -3.377 | -15.60 |
| fra | -3.043 | -41.31 | -3.862 | -49.24 | -2.700 | -33.04 | -3.716 | -19.93 |
| gre | -0.952 | -11.07 | -2.363 | -33.72 | -0.661 | -6.85 | -2.269 | -15.22 |
| jap | -3.530 | -34.44 | -3.883 | -35.80 | -3.032 | -26.07 | -3.639 | -14.25 |
| por | -1.040 | -12.99 | -2.577 | -33.68 | -0.790 | -9.02 | -2.412 | -11.21 |
| spa | -1.686 | -20.67 | -2.939 | -36.89 | -1.376 | -15.15 | -2.990 | -23.01 |

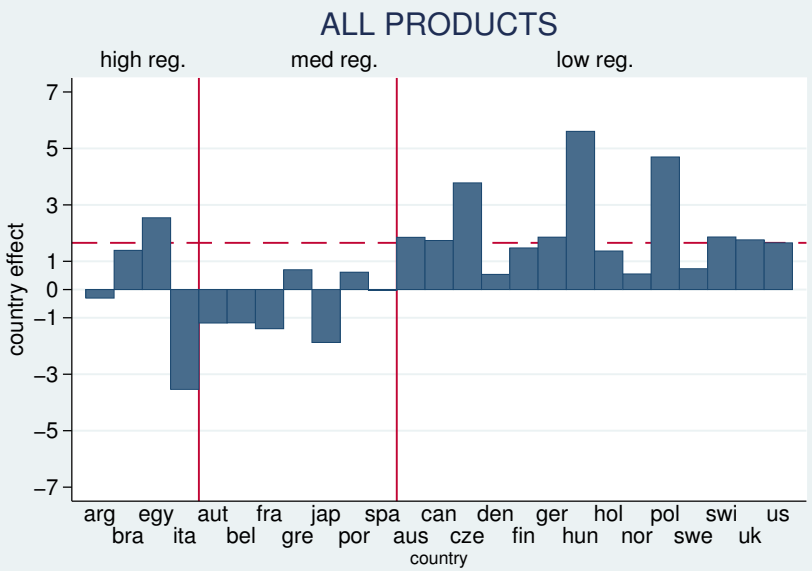
# Pooled countries results (III): 2nd stage (cont.)

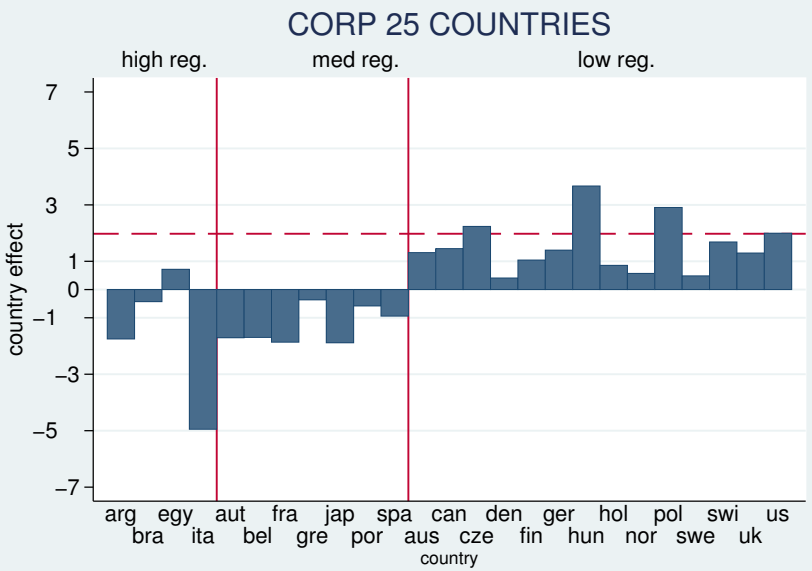
| | ALL | | CORP 25C | | MOL 25C | | C+M 25C | |
|---|---|---|---|---|---|---|---|---|
| | coef | t-stat | coef | t-stat | coef | t-stat | coef | t-stat |
| aus | 0.195 | 2.44 | -0.687 | -9.51 | 0.177 | 1.98 | -0.695 | -3.64 |
| can | 0.084 | 1.47 | -0.545 | -8.09 | 0.085 | 1.23 | -0.440 | -2.87 |
| cze | 2.124 | 27.54 | 0.240 | 3.01 | 1.932 | 22.85 | 0.326 | 1.88 |
| den | -1.117 | -16.20 | -1.588 | -20.25 | -1.027 | -13.59 | -1.281 | -9.19 |
| fin | -0.181 | -2.55 | -0.951 | -12.48 | -0.180 | -2.28 | -0.762 | -5.12 |
| ger | 0.202 | 3.10 | -0.600 | -8.84 | 0.189 | 2.61 | -0.701 | -5.36 |
| hun | 3.950 | 54.96 | 1.672 | 23.62 | 3.609 | 45.27 | 1.263 | 7.59 |
| hol | -0.290 | -4.05 | -1.139 | -16.84 | -0.271 | -3.41 | -0.842 | -3.81 |
| nor | -1.103 | -15.51 | -1.424 | -19.40 | -1.018 | -13.03 | -0.902 | -4.29 |
| pol | 3.043 | 41.31 | 0.911 | 11.53 | 2.781 | 34.24 | 0.612 | 2.42 |
| swe | -0.916 | -13.81 | -1.512 | -21.65 | -0.839 | -11.42 | -1.291 | -9.05 |
| swi | 0.208 | 2.43 | -0.311 | -4.08 | 0.172 | 1.82 | -0.238 | -1.99 |
| uk | 0.107 | 1.42 | -0.703 | -10.05 | 0.111 | 1.34 | -0.435 | -3.43 |
| intercept(US) | 1.655 | 5.53 | 1.997 | 3.97 | 0.703 | 0.48 | 2.074 | 4.06 |
| N | 37846 | | 11438 | | 26938 | | 1154 | |
| r2-w | 0.787 | | 0.851 | | 0.782 | | 0.878 | |
| r2-o | 0.471 | | 0.467 | | 0.469 | | 0.742 | |
| F | 2851.0 | | 2403.7 | | 1971.9 | | 14764.7 | |

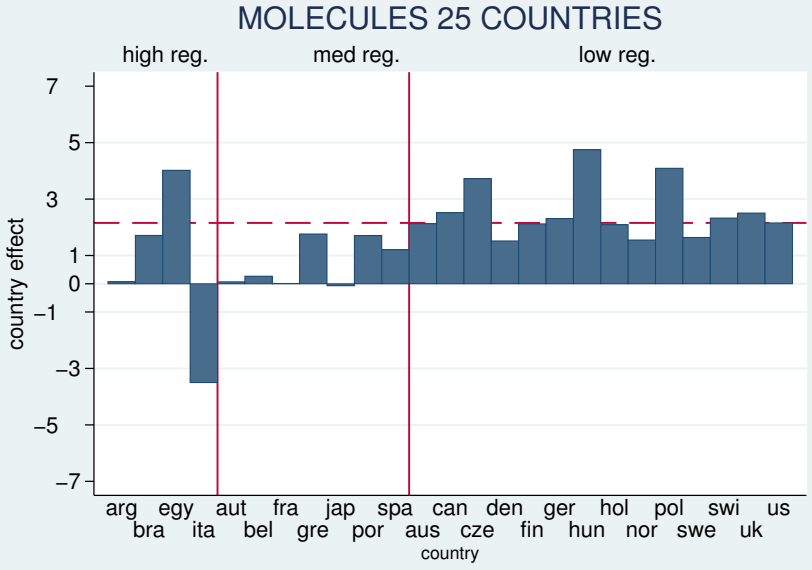
# Pooled countries results (IV): 2nd stage

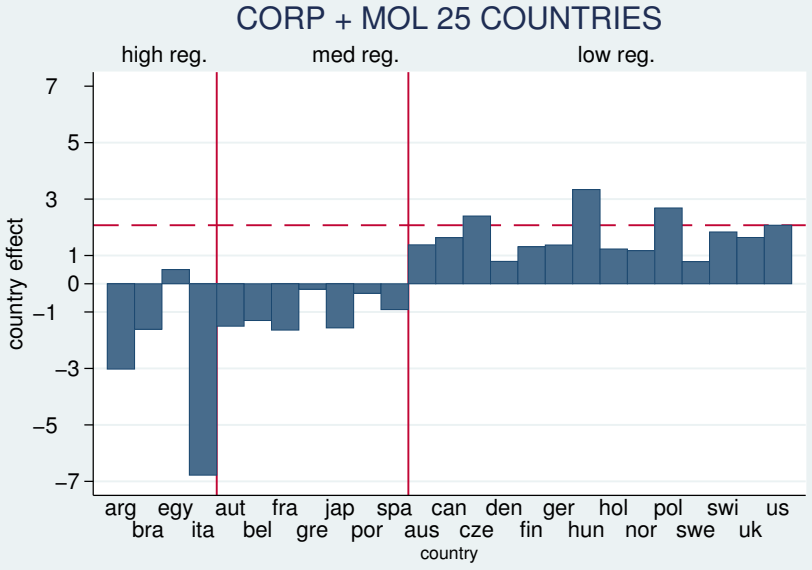
- Exclusively-local corporation products: approx 15% price reduction.
- Product from a local multinational: no clear effect on prices.
- Price for generic products: between -0.15 and -0.20 percent lower.
- Age affects negatively prices expect for widespread products from multinationals present in all the countries.

# Pooled countries results (V): Country effects (I)



# Pooled countries results (V): Country effects (II)

Average differential wrt US level

| Regulatory group | All | C 25P | M 25P | C+M 25P |
|---|---|---|---|---|
| Very high | -1.63 | -3.60 | -1.58 | -4.80 |
| high | -2.28 | -3.29 | -1.44 | -3.14 |
| *Spain* | -1.69 | -2.94 | -1.37 | -2.99 |
| Low | 0.48 | -0.51 | 0.40 | -0.41 |
| *Canada* | 0.08 | -0.54 | 0.36 | -0.44 |
| *Nordic countries* | -0.83 | -1.37 | -0.45 | -1.06 |

- Price in developing countries or very regulated (European) countries are lower than in less regulated countries.
- As we move in the C dimension, all the country specific effects decrease and the differences wrt US increase significantly.
- When we move in the M dimension, the differences between countries decrease.
- Canada has similar prices to US as a whole and for widespread products and lower prices for innovative products.
- The nordic countries, despite been less regulated than other EU countries, seem to be more successful in containing prices.

# Pooled countries results: country effects (III)

- Thus, US has a relatively higher price for products manufactured by multinationals, and a lower price with products that are “very common".
  $\Longrightarrow$ U.S. does well for goods where there can be competition and other countries successful at capping the prices of patented innovative goods.
- Thus regulation seems to reduce the price of innovative products and sustains artificially that of widespread products.
  $\Longrightarrow$ it reduces the level of competition

# Pooled countries results by therapeutical class

- Similar qualitative picture than pooled analysis.

# Concluding remarks

- We investigated the determinants of prices for pharmaceuticals.
- More extensive database than most previous studies, large number of controls and close attention to empirical strategy and specification.
- We have evidence that quality matters for prices and *all* multinational corporations obtain a price advantage.
- Explanation for the absence of a local price premium is that multinationality confers a protection
  - A reference price (or similar) policy in one country becomes a “commitment device” to avoid lowering price in another one: akin to the low-price guarantees in IO organization literature.
- Our results do not support the view that the U.S. has generally higher prices than the rest of the countries in the sample.
  - But high regulation does entail a price advantage in innovative products.
- In summary, regulation reduces prices of innovative products and sustains prices of less innovative products.