14.582 International Trade II — Lecture 9: Measuring the Gains from Trade (Empirics) —

MIT 14.582 (Week 5)

Plan of Today's Lecture

1. Measuring the first order gains from price changes
    1. Deaton (EJ, 1989)
2. Adding more structure
    1. Porto (JIE, 2005)
3. Including the gains from Variety
    1. Broda and Weinstein (2005)
    2. Atkin, Faber, Gonzalez Navarro (2016)

Introduction

- We already talked about some more reduced form methods of measuring the gains from trade (Bernhofen and Brown, Feyrer)
- If we add a little more structure to the problem, and have good enough data, we can draw out richer conclusions.
  - Can think of these approaches as lying someway between reduced form and structural estimation
  - Will be particularly valuable for teasing out nuanced distributional effects—particularly important given political aspects of any policy change
- First, use consumer theory to map gains to price changes (Deaton 1989)
- Then add other dimensions:
  - Wage responses (Porto 2005)
  - Variety (Feenstra 1994)

Measuring First Order Gains from Price Changes

- There are many reasons why we might want to know the effect of price changes:
  - Impacts of tax policy (Deaton's application—but it's an export tax!)
  - Impacts of world food price rises (De Janvry, Sadoulet 2008, 2009)
  - Impacts of trade liberalization (Porto JIE, Nicita JDE)
- And typically we are interested in both average effects and distributional effects

Deaton (1989) Background

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  - What would be the welfare effects of removing it?
    - Will use various non-parametric methods to see how different households are affected
  - NB: Exposition clearer in Deaton's (incredible) 1997 book: *The analysis of household surveys: a microeconometric approach to development policy*

Non-Parametric Regressions

- Want to estimate distribution of x, or regression of y on x, with no parametric assumptions. . .
- Essentially calculate the average y at each value of x, but usually don't have enough data to do this
  - So take weighted average of y's at nearby x's
- But biased (due to concavity of function or uneven spacing of observations—see Deaton)
  - Fan's locally weighted regression: Run a regression at say 50 evenly spaced points in your data set, where observations weighted by kernel weights from that point. Then get predicted values at 50 points and join the dots

Income

- First let's look at kernel density estimates of income

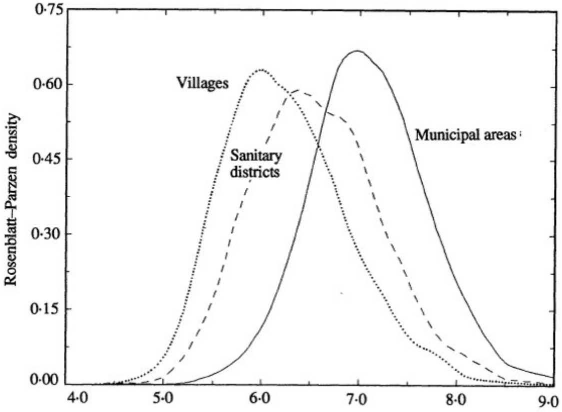

Fig. 1. Sectoral distributions.

- So rural areas poorer. No case for redistributing to urban

Consumption (Engel curves)

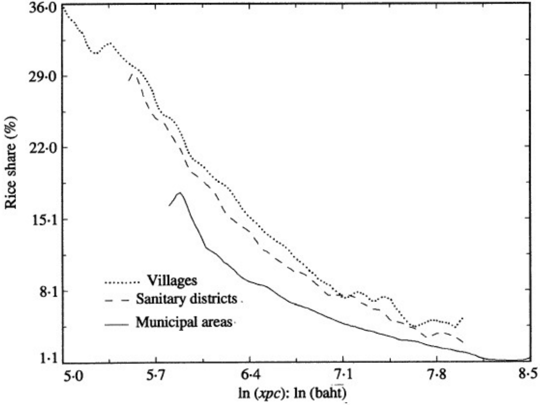

Fig. 2. Rice share regressions. Bandwidths are 0·10, 0·15 and 0·10.

Production

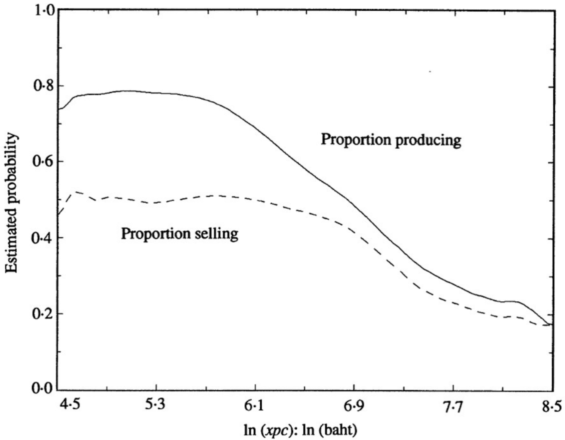

Fig. 7. Rice farming: All village households. Bandwidth = 0·50.

- 80% of poor grow rice, 50% of poor sell (so net producers-must gain)
- So conditional on producing, proportion selling increases with income

Expenditure Ratio: budget share - prod share

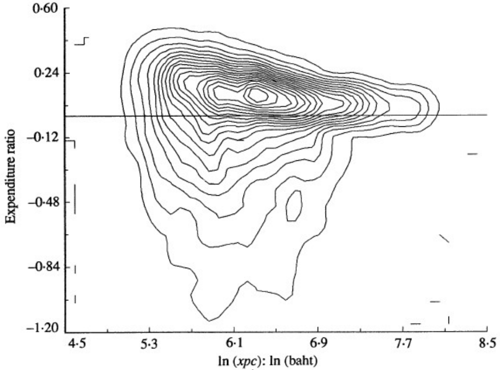

Fig. 10. Net purchases: 5,836 village households; 3,001 make net purchases; 2,677 make net sales.

- Removal of tax raises prices. Many of those who would gain are in the middle of the income distribution-certainly not richest.
- Although average household loses from removal of tax, gain on average as those losing households lose small, winners gain big.

Average Effects (B/E: Ratio of Net Sales to Consumption)

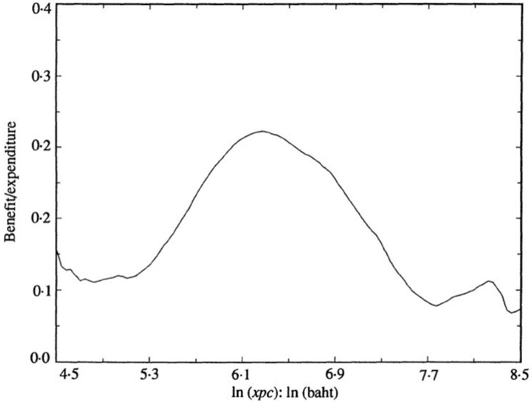

Fig. 12. Welfare effects: All village households. Bandwidth = 0·5.

Nuanced Picture: Who Gains from Export Tax Removal

- 80% of poor grow rice, 50% of poor sell rice (so net producers-must gain)
- Rich less likely to farm (so less likely to gain)
  - But conditional upon farming, rich sell more (more likely to gain)...
  - Rich also consume relatively less (Engel's law) (more likely to gain)
- Middle of distribution gains the most! Little effect on distribution between poor and rich in rural areas...
- What did we ignore?

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- Middle of distribution gains the most! Little effect on distribution between poor and rich in rural areas...
- What did we ignore?
  - Rural-urban issues: Urban guys lose obviously...
  - Tax revenue
  - Reduction in deadweight loss (but could be optimal tariff)

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Extensions on the First-Order Theme

- Porto (JIE, 2005):
  - Can do this for every good (for which we observe expenditure shares and price changes) and add up all of the effects within each household.
  - For traded goods, assume perfect pass-through of foreign price change (or import price change) into domestic price p_T
  - For non-traded goods, estimate a (somewhat ad-hoc, but flexible) system relating p_{NT} to p_T
  - Estimate wage response ("Stolper-Samuelson derivatives")
- Artuc, Porto, and Rijkers (2017):
  - Apply Porto (2005) idea to data from 54 developing countries

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Broda & Weinstein (QJE 2006)

- Question: How does globalization affect welfare through the gains from variety?
- Theoretical framework: CES utility specification.
- Empirical methodology:
  - Data: 7 or 10-digit HTS US imports by country of origin 1972-2001.
    - So a variety will be a product-country pair!
  - Estimation: Estimate product group specific elasticities of substitution following methodology of Feenstra (1994).
- Feenstra and Weinstein (JPE, 2017) extend this approach using Translog instead of CES (allows "crowding" of additional varieties when already many varieties).
  - Real goal is to get at variable markups.

Broda & Weinstein (2006) - Motivation

212% increase: roughly half increase from # goods, half from #countries per good

TABLE I
VARIETY IN U. S. IMPORTS (1972–2001)

U. S. Imports 1972–1988

	Year	Number of TSUSA categories	Median number of exporting countries	Average number of exporting countries	Total number of varieties (country-good pairs)	Share of total U. S. imports in year
	(1)	(2)	(3)	(4)	(5)	(6)
All 1972 goods	1972	7731	6	9.2	71420	1.00
All 1988 goods	1988	12822	9	12.2	156669	1.00
Common 1972–1988	1972	4167	6	8.4	35060	0.41
Common 1972–1988	1988	4167	10	12.2	50969	0.33
1972 not in 1988	1972	3553	7	10.2	36355	0.59
1988 not in 1972	1988	8640	8	12.7	105696	0.67

U. S. Imports 1990–2001

	Year	Number of HTS categories	Median number of exporting countries	Average number of exporting countries	Total number of varieties (country-good pairs)	Share of total U. S. imports in year
	(1)	(2)	(3)	(4)	(5)	(6)
All 1990 goods	1990	14572	10	12.5	182375	1.00
All 2001 goods	2001	16390	12	15.8	259215	1.00
Common 1990–2001	1990	10636	10	12.4	132417	0.73
Common 1990–2001	2001	10636	13	16.3	173776	0.67
1990 not in 2001	1990	3936	10	12.7	49958	0.27
2001 not in 1990	2001	5754	11	14.8	85439	0.33

Source: NBER CD-ROM and http://data.econ.ucdavis.edu/international/usixd/wp5514d.html

Broda & Weinstein (2006) - Theory: Feenstra (1994)

- How do we value new goods?
  - Basic idea is to find the price at which demand would be zero (virtual price after Hicks (194)) and feed that price into price index pre price change.
  - But for CES, Hicksian virtual price is infinite. Feenstra (1994) showed that you can integrate under demand curve and obtain a simple expression for the change in the price index.

Broda & Weinstein (2006) - Theory: Feenstra (1994)

- Assume Cobb-Douglas preferences over product groups g, CES preferences across varieties v within product groups (with market shares λ_{gv}^{t}):

$$\frac{P_t}{P_{t-1}} = \prod_{g \in G} \left\{ \left(\frac{\sum_{v \in V_g^c} \lambda_{gv}^{t}}{\sum_{v \in V_g^c} \lambda_{gv}^{t-1}} \right)^{\frac{1}{\sigma_g - 1}} \prod_{v \in V_g^c} \left(\frac{p_{gv}^{t}}{p_{gv}^{t-1}} \right)^{\omega_{gv}} \right\}^{\alpha_g}$$

where ω_{gv} are ideal log-change weights from Sato-Vartia price index

$$\omega_{gsh} = \left(\frac{\tilde{\lambda}_{gv}^{t} - \tilde{\lambda}_{gv}^{t-1}}{\ln \tilde{\lambda}_{gv}^{t} - \ln \tilde{\lambda}_{gv}^{t-1}} \right) / \sum_{v \in V_g^c} \left(\frac{\tilde{\lambda}_{gv}^{t} - \tilde{\lambda}_{gv}^{t-1}}{\ln \tilde{\lambda}_{gv}^{t} - \ln \tilde{\lambda}_{gv}^{t-1}} \right),$$

where $\tilde{\lambda}_{gv}^{t}$ denote market shares only considering continuing varieties $v \in V_g^c$.

- The adjustment term for exiting and entering varieties over time enters as a multiplicative term on the Sato-Vartia price index for persistent varieties.
  - Thus, the higher the expenditure share on new varieties (and the lower the one on disappearing ones), the lower is $\sum_{v \in V_g^c} \lambda_{gv}^{t}$ and the smaller is the exact price index relative to the conventional price index.

Broda & Weinstein (2006) - Data

- 7 digit HTS US imports by country of origin 1972-1990.
- 10-digit HTS US imports by country of origin 1990-2001.

- A "variety" is a country specific 7 or 10-digit import flow.

Broda & Weinstein (2006) - Estimation

- Four steps:
  - Estimate σ_g by product group.
  - Compute $\sum_{v \in V_g^c} \lambda_{gv}^t$ for each product group from the trade data.
  - Compute expenditure shares to compute standard (unadjusted) import CPI.
  - Compute overall import price index (standard and variety adjustment term).

Broda & Weinstein (2006) - Estimation

- Step 1: Estimating σ_g's for each product group:
  - Standard approach would be to regress log market shares on log prices and fixed effect out the price index term to estimate σ_g.
    - But, simultaneity problem: prices likely endogenous to demand shocks (if supply is anything but perfectly elastic).
  - Address endogeneity in price changes following Feenstra (1994) (and thereby Leamer, 1981).
  - Rather than looking for instruments (supply shifters?), instead make the assumption that the contemporaneous error terms in both equations are independent, and identify off heteroskedasticity (i.e. different variances across countries).

Digression on Identification through Heteroskedasticity

- Old idea: Wright (1928), Leamer (1981)
  - Basic logic (drawing on Rigobon REStat 2003):
    - Start with standard supply and demand problem. Need supply shock to trace out demand.

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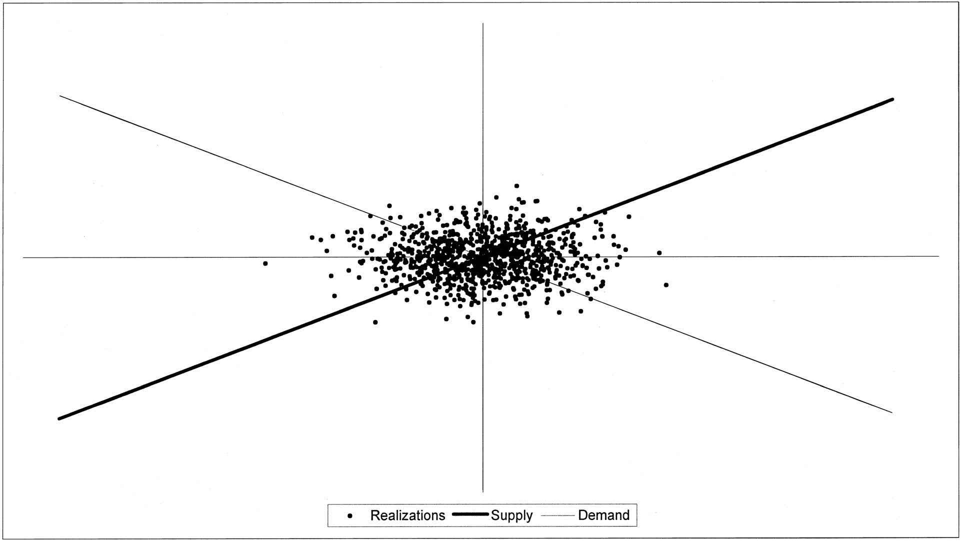

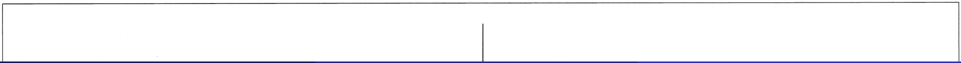

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    - Now what if we had another sample where demand shocks had same variance, but supply shocks much more variable.
    - Since most of variation is now in supply, demand curve starts to be traced out.

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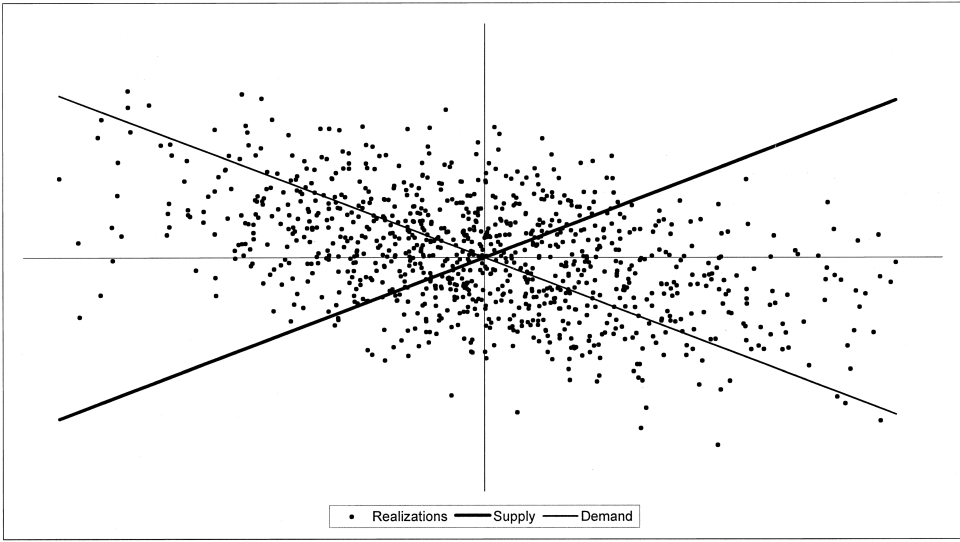

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    - Now what if we had another sample where demand shocks had same variance, but supply shocks much more variable.
    - Since most of variation is now in supply, demand curve starts to be traced out.
    - As variance of supply goes to infinity, demand curve is identified.
    - But more generally, as long as demand and supply variances differ by different amounts in two regimes and shocks are uncorrelated, the system is identified.
    - Rigobon gives example of estimating relationship between returns of ARG, MEX and BRA bonds where regimes are crisis/non-crisis periods.

Digression on Identification through Heteroskedasticity

- Suppose that you have data on U.S. imports, prices and quantities, of widgets from two exporting countries, $i = 1, 2$, over time $t = 1, \ldots$.
  - You know that prices and quantities satisfy:

$$\begin{aligned} p_{t,i} &= \beta q_{t,i} + \varepsilon_{t,i} \\ q_{t,i} &= \alpha p_{i,t} + \eta_{t,i} \end{aligned}$$

  - You also know that demand and supply shocks are uncorrelated $\sigma_{\varepsilon\eta,i} = 0$ for both countries.

Digression on Identification through Heteroskedasticity

- If you only had data from one exporting country, you wouldn't be able to identify α and β separately. Formally, you could estimate the covariance matrix

$$\Omega_i = \begin{pmatrix} var\,(p_i) & cov(p_i, q_i) \\ cov(p_i, q_i) & var(q_i) \end{pmatrix} = \frac{1}{(1-\alpha\beta)^2} \begin{pmatrix} \beta^2\sigma^2_{\eta,i} + \sigma^2_{\varepsilon,i} & \beta\sigma^2_{\eta,i} + \alpha\sigma^2_{\varepsilon,i} \\ \beta\sigma^2_{\eta,i} + \alpha\sigma^2_{\varepsilon,i} & \alpha^2\sigma^2_{\varepsilon,i} + \sigma^2_{\eta,i} \end{pmatrix}$$

  - But that's only three moments to pin down four variables: α, β, σ_η, and σ_ε.

Digression on Identification through Heteroskedasticity

- Recall:

$$\Omega_i = \begin{pmatrix} var\,(p_i) & cov(p_i, q_i) \\ cov(p_i, q_i) & var(q_i) \end{pmatrix} = \frac{1}{(1-\alpha\beta)^2} \begin{pmatrix} \beta^2\sigma^2_{\eta,i} + \sigma^2_{\varepsilon,i} & \beta\sigma^2_{\eta,i} + \alpha\sigma^2_{\varepsilon,i} \\ \beta\sigma^2_{\eta,i} + \alpha\sigma^2_{\varepsilon,i} & \alpha^2\sigma^2_{\varepsilon,i} + \sigma^2_{\eta,i} \end{pmatrix}$$

  - Now since we have two exporting countries *and* we have assumed that α and β were the same for the two exporting countries, we have six moments and six unknowns: α, β, $\sigma_{\eta,i}$, and $\sigma_{\varepsilon,i}$. As long as the six equations are linearly independent, α and β are exactly identified.
  - A necessary condition for identification is that Ω_1 and Ω_2 are not proportional to one another, e.g. $\sigma^2_{\eta,1} = \lambda\sigma^2_{\eta,2}$ and $\sigma^2_{\varepsilon,1} = \lambda\sigma^2_{\varepsilon,2}$.
    - The *relative* variance of the shocks, $\sigma^2_{\eta,i}/\sigma^2_{\varepsilon,i}$, must vary across the two countries but not the slopes α and β! Parameter stability is key!
    - Intuitively, one is more likely to trace out the demand curve using data from the country with supply shocks that are relatively more volatile.
  - Question: are these conditions likely to hold?

Broda & Weinstein (2006) - Results on Sigmas

TABLE IV
SIGMAS FOR DIFFERENT AGGREGATION LEVELS AND TIME PERIODS

Period	Statistic	TSUSA/HTS	SITC-5	SITC-3
1972–1988	Mean*	17.3	7.5	6.8
	Standard error*	0.5	0.5	1.2
	Median	3.7	2.8	2.5
	Standard error	0.03	0.04	0.11
	Median varieties per category**	15	54	327
	Nobs of categories	11040	1457	246
1990–2001	Mean*	12.6	13.1 (6.6)	4.0
	Standard error*	0.5	5.9 (0.3)	0.5
	Median	3.1	2.7	2.2
	Standard error	0.04	0.06	0.13
	Median varieties per category**	18	52	664
	Nobs of categories	13972	2716 (2715)	256

(*) Estimates of the mean and standard error are adjusted for parameter censoring. The numbers in brackets in the SITC-5 1990–2001 were calculated dropping the one outlier elasticity of 16049.

(**) As in Table III, a variety is defined as a TSUSA/HTS-country pair.

For the TSUSA/HTS column: number of observations is equivalent to the median number of countries.

For SITC-5 (SITC-3) column, it is the median number of TSUSA/HTS-good/country pairs in a given SITC-5 (SITC-3) level.

Broda & Weinstein (2006) - Robustness Checks on Sigmas

- σ_g's are larger for more disaggregated product groups.
- σ_g's are lower for more differentiated product groups (Rauch, 1999).
- σ_g's are higher for goods in organized exchanges.
- σ_g's get lower over time.

Broda & Weinstein (2006)

- Main finding: Gains from variety appear to be big: 1.2% annually (28% for 1972-01).
- Empirically, a lot hinges on estimation of sigmas.

- Many more papers using the Feenstra (1994) approach....
- Soderbery (2015) suggests changes to the elasticity estimation; Redding and Weinstein (2016) allows for stochastic preference shocks.
- Recent empirical studies have started linking gains from variety to policy effects (rather than measuring total observed changes) (e.g. Goldberg et al. (2011)).
- So far, there is relatively little work on differential gains from variety across households (Li 2012, Jaravel 2016, Faber and Fally 2016).

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Atkin, Faber, Gonzalez Navarro (JPE, 2018)

- Focus on the welfare effects of foreign supermarket entry (FDI) on Mexican households in the location of entry
- Why should we care?
  - Retail on average accounts for 15-20% of employment, 10-15% of GDP, and $>$50% of household expenditures.
  - FDI-led "Supermarket Revolution" in the developing world
  - Heated policy debates, and stark differences in policy choices across countries.
- Focus on Mexico during the main wave of foreign retail expansion.
  - Number of foreign-owned supermarkets increased from 365 at the end of 2001 to 1335 stores by 2014.
  - Foreign stores charge 12% less for same barcode, more varieties, fancier/cleaner, located further rout of town

Welfare Expression

- Again start with compensating variation:
  - $CV = e(\mathbf{P}^1, u_h^0) - y_h^1$
  - $$= \underbrace{\left[e(\mathbf{P}^1, u_h^0) - e(\mathbf{P}^0, u_h^0)\right]}_{\text{Cost of living effect } (CLE)} - \underbrace{\left[y_h^1 - y_h^0\right]}_{\text{Income effect } (IE)}$$
- In principle can read $y_h^1 - y_h^0$ off data if have exogenous policy shock.
- But as in Feenstra (1994) can't observe price changes for products in exiting/entering stores.

Estimation of Consumer Gains

- Use a multi-tier asymmetric CES utility function:

$$U = \prod_{g \in G} [Q_g]^{\alpha_{gh}} : \quad \text{Cobb-Douglas over product groups } g$$

$$Q_g = \Big(\sum_{s \in S_g} \beta_{gsh} q_{gs}^{\frac{\eta_{gh}-1}{\eta_{gh}}}\Big)^{\frac{\eta_{gh}}{\eta_{gh}-1}} : \quad \text{CES over stores } s$$

$$q_{gs} : \quad \text{preferences within store-good unspecified for now}$$

  - Can then apply the Feenstra (1994) formula, where here a variety is a store-brand.

Estimation of Consumer Gains

- Full welfare expression for consumer gains:
  - Causal effects of foreign retail entry on consumer prices (by from monthly store-barcode-level CPI microdata 2002-2014)
  - Causal effects of foreign retail entry on market shares (from store-barcode-level Consumer Panel 2011-2014)
  - Demand parameters estimated off price variation in the Consumer Panel
  - Initial budget shares (from biannual household surveys 2006-2012).
  - (All by modern/traditional store and product type)

$$\frac{CLE}{e(\mathbf{P}_d^0, \mathbf{P}_f^{0*}, u_h^0)} = \prod_{g \in G} \left\{ \left(\frac{\sum_{s \in S_g^{dc}} \phi_{gsh}^1}{\sum_{s \in S_g^{dc}} \phi_{gsh}^0} \right)^{\frac{1}{\eta_{gh}-1}} \prod_{s \in S_g^{dc}} \left(\frac{r_{gs}^1}{r_{gs}^0} \right)^{\omega_{gsh}} \right\}^{\alpha_{gh}} - 1$$

Estimation of Production-Side Gains

- Full welfare expression for production side gains:
  - Causal effects of foreign retail entry on wages and employment (modern/traditional retail + other sectors from ENEU Quarterly Employment Surveys 2002-2012)
  - Causal effects of foreign retail entry on traditional store profits (from retail census 2004 and 2009)
  - Initial income shares from biannual household surveys (ENIGH 2006-2012).

$$\frac{IE}{e(\mathbf{P}_d^0, \mathbf{P}_f^{0*}, u_h^0)} = - \underbrace{\sum_{i \in \{\tau,\mu\}} \left[\theta_{ilh}^0 \left(\frac{l_{ih}^1 - l_{ih}^0}{l_{ih}^0} \right) \right]}_{\text{Retail labor income effect}} - \underbrace{\sum_{i \in \{\tau\}} \left[\theta_{i\pi h}^0 \left(\frac{\pi_{ih}^1 - \pi_{ih}^0}{\pi_{ih}^0} \right) \right]}_{\text{Retail profit effect}}$$

$$- \underbrace{\sum_{i \in \{o\}} \left[\theta_{ilh}^0 \left(\frac{l_{ih}^1 - l_{ih}^0}{l_{ih}^0} \right) + \theta_{i\pi h}^0 \left(\frac{\pi_{ih}^1 - \pi_{ih}^{i0}}{\pi_{ih}^0} \right) \right]}_{\text{Other income effect}}$$

Consumer Retail Prices (Domestic Stores)

- Want to compare prices at domestic stores pre and post foreign store entry.
- But timing of foreign store entry may be endogenous to domestic price changes:
  - Benefit of this setting is have many entry events with staggered timing
  - Have enough variation to see if prices were rising (or falling) pre-entry

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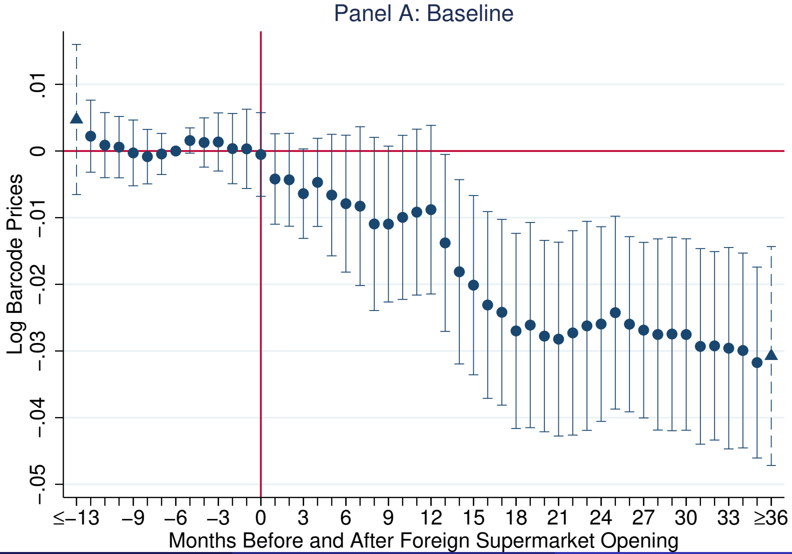
  - Have enough variation to see if prices were rising (or falling) pre-entry
- Event study specification:

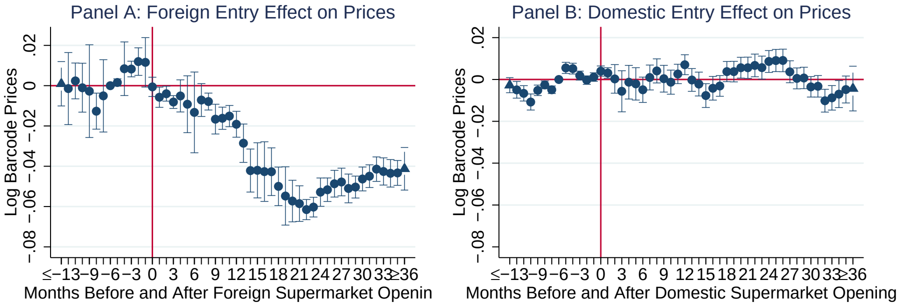
$$\ln p_{gsbmt} = \sum_{j=-13}^{36} \beta_j \, I\left(MonthsSinceEntry_{mt} = j\right) + \delta_{gsbm} + \eta_t + \epsilon_{gsbmt}$$

  - where g =product-group, s=store, b=barcode, m=municipality, t=month.
  - Allows AFG to test necessary condition for exogeneity of timing of store entry.

Consumer Retail Prices (Domestic Stores)

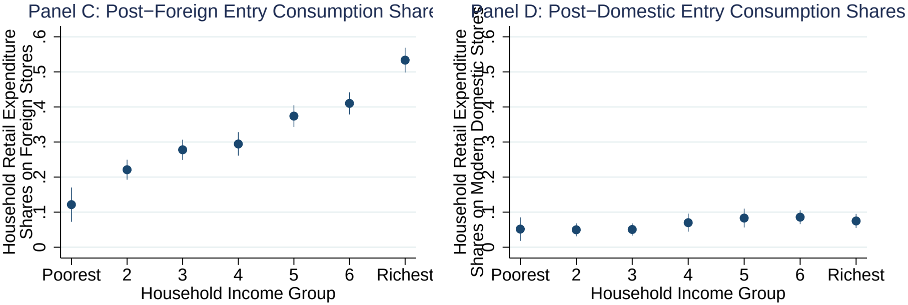


Domestic Entry Placebo



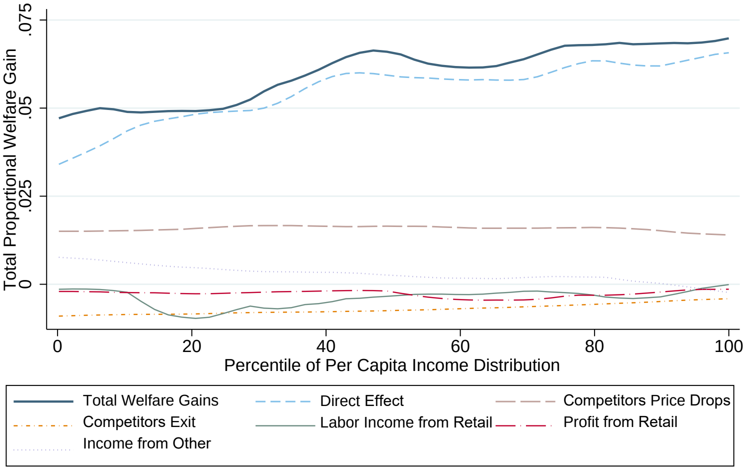
- Don't see similar effects for most comparable domestic chains by average floor space per store (Soriana, Chedauri, Gigante or Comercial Mexicana).

Foreign Store Market Shares



- Don't see similar effects for most comparable domestic chains by average floor space per store (Soriana, Chedauri, Gigante or Comercial Mexicana).

Quantification



- Gains are large and regressive (rich spend larger share of retail expenditure at foreign stores—value their varieties and amenities more?).