ARE 202: Welfare: Tools and Applications
Spring 2018

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Lecture notes 04 – Quantifying Consumer Welfare

Plan

1. Tools
   - EV, CV
   - Consumer surplus
   - Price indexes
2. Illustrations
   - Atkin, Faber, Gonzales-Navarro (2016): impact of foreign store openings in Mexico
   - PS3: Consumer surplus: Uber (Cohen et al 2016)

Motivation

- Welfare is what we care about (eventually)
- But lots of difficulties:
  - How to quantify welfare changes?
  - How to compare effects across individuals?
- There are several ways to answer these questions:
  Definitions and properties of EV, CV, CS and ideal price index
- Important to know how to apply these tools, and know how they differ

Quantifying welfare changes

Quantifying the effect of change in income:

- Easy: that's the change in income

Harder: quantifying the effect of change in prices.

Two approaches:

1) Change in income to compensate the change in prices?
   = **Compensating Variation** (CV)
2) Change in income equivalent to the change in prices?
   = **Equivalent Variation** (EV)

Both approaches make use of the expenditure function $e(p, u)$.

Quantifying welfare changes

- Consider a change in prices from p to p' (fixed income w). Utility goes from $u = v(p, w)$ to $u' = v(p', w)$.
- The change in income that would *compensate* the change in prices would correspond to:

$$\textit{Compensating Variation} = e(p, u) - e(p', u) = w - e(p', u)$$

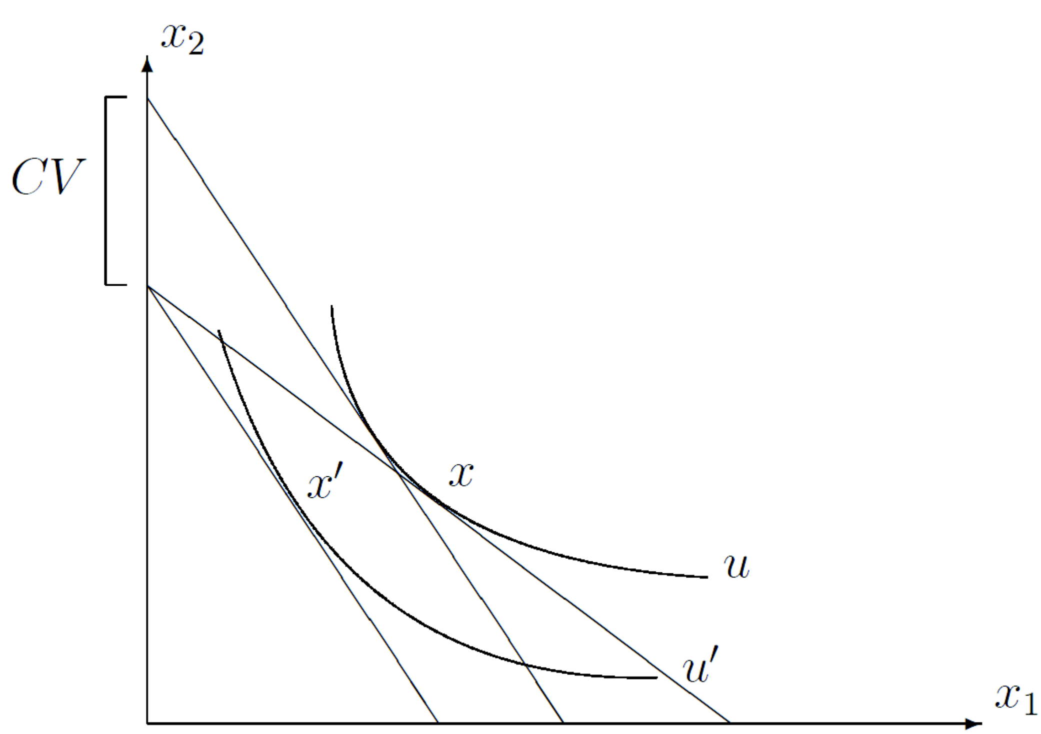
[using: previous utility u, new prices p']
Note that we also have: $v(p', w + CV) = v(p, w)$

- The change in income that would be *equivalent* to the change in prices would correspond to:

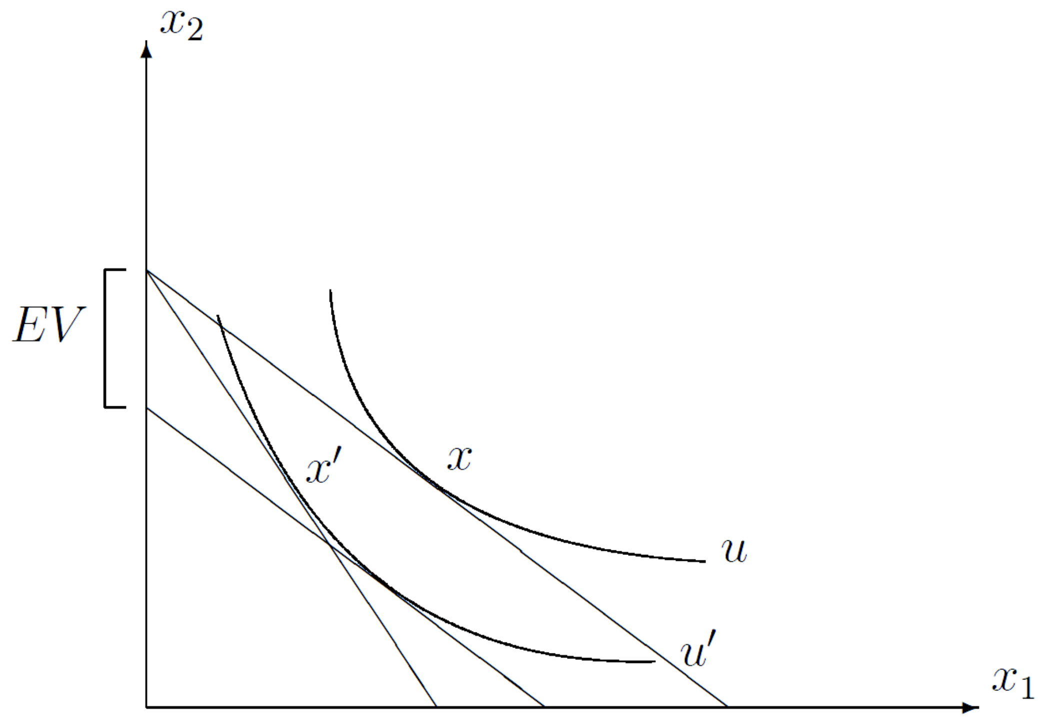
$$\textit{Equivalent Variation} = e(p, u') - e(p', u') = e(p, u') - w$$

[using: new utility u', previous prices p]

Compensating variation



Equivalent variation



Link to the shape of the demand curve

- Suppose that the prices change only for good i
- Using Shephard's Lemma, we get:

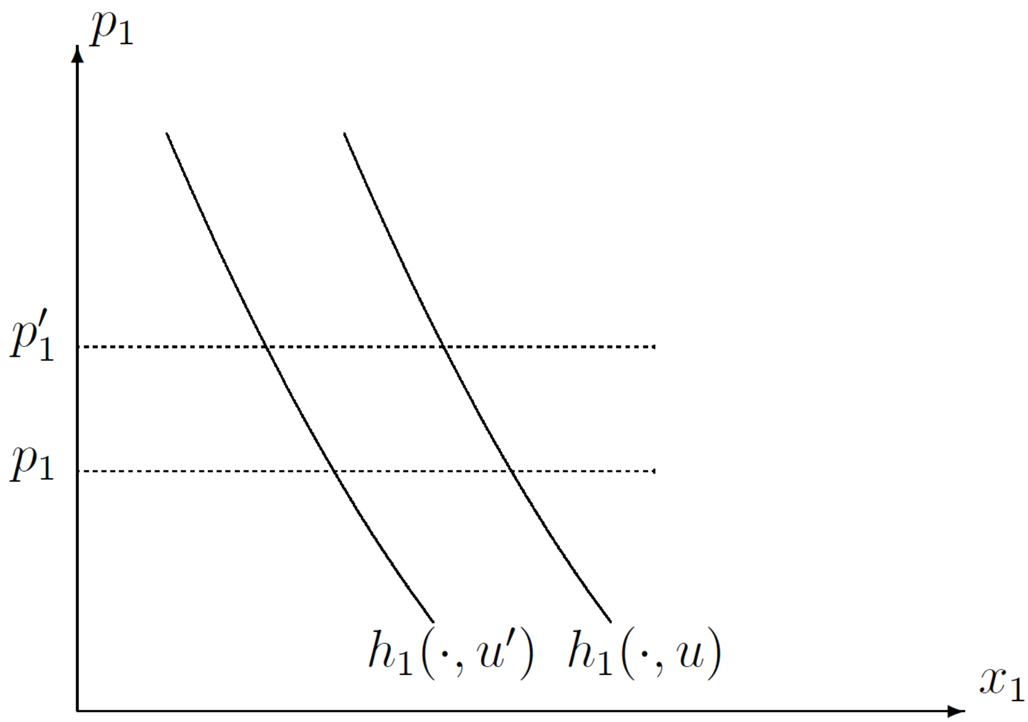
$$CV = e(p,u) - e(p',u) = \int_{p_i'}^{p_i} \frac{\partial e(p,u)}{\partial p_i} dp_i = \int_{p_i'}^{p_i} h_i(p,u) dp_i$$

- Similarly:

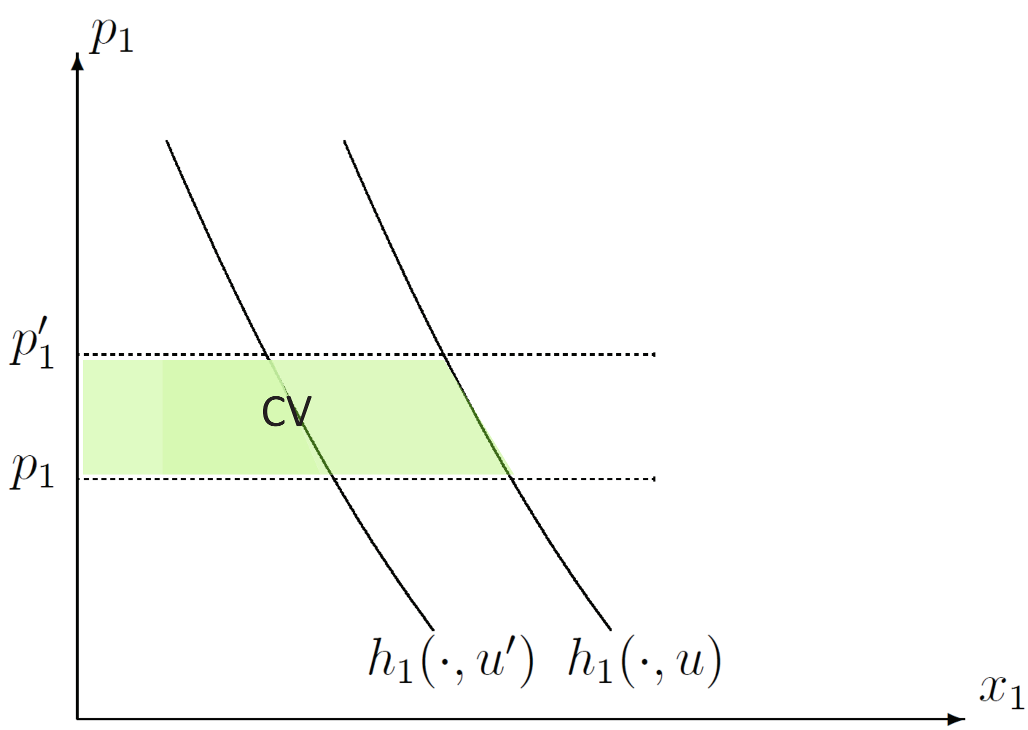
$$EV = e(p,u') - e(p',u') = \int_{p_i'}^{p_i} \frac{\partial e(p,u')}{\partial p_i} dp_i = \int_{p_i'}^{p_i} h_i(p,u') dp_i$$

- Graphically: areas "below" the Hicksian Demand (i.e. to the left since prices are on the Y-axis)

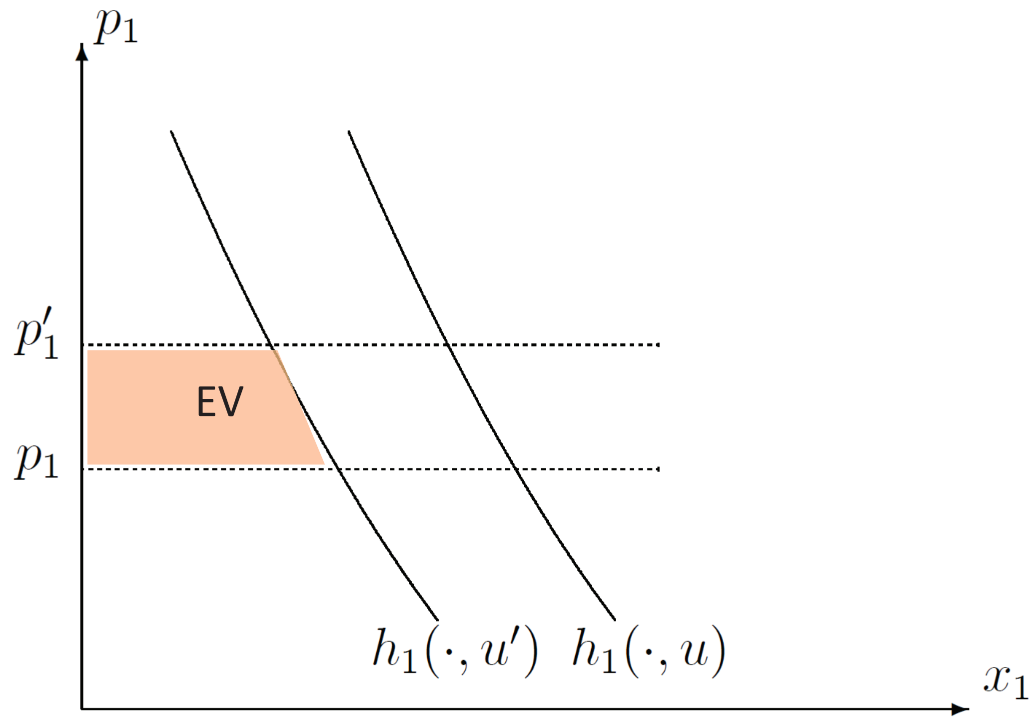
Hicksian demand for utility u and u', assuming $u' < u$ and normal good



Compensating variation



Equivalent variation



Consumer Surplus

- What if we use Marshallian instead of Hicksian Demand?
- Following the same idea, we define consumer surplus:

$$CS = \int_{p_i'}^{p_i} x_i(p, w) dp_i$$

- At the end points, notice that:

$$x_i(p', w) = h_i(p', u')$$

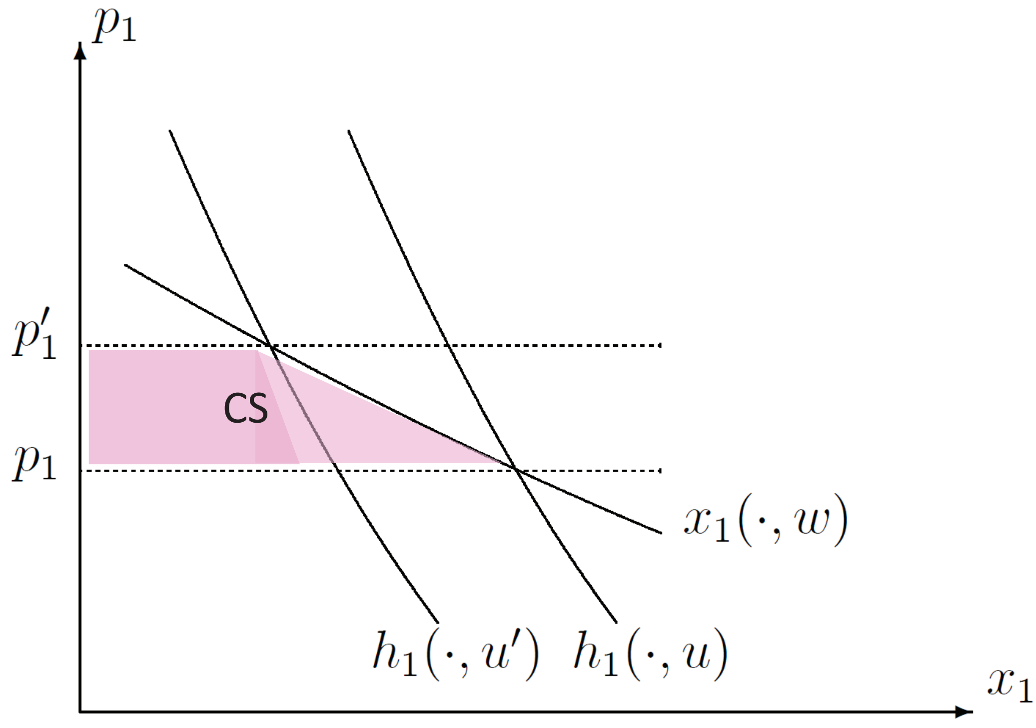
$$x_i(p, w) = h_i(p, u)$$

- With a normal good, we obtain:

$$EV < CS < CV$$

(reversed for an inferior good)

Consumer surplus



A simple case

- Assume quasi-linear preferences

$$U(x) = x_0 + \sum u_i(x_i)$$

- Recall some of the properties of quasi-linear prefs:
  - Lagrange multiplier $\lambda = p_0 = 1$ (normalization of p_0)
  - Demand such that: $u_i'(x_i) = p_i$
    Marshallian demand x_i only depends on price p_i
  - **No wealth effect** (except for numeraire good x_0),
    Hence same price effect for Hicksian and Marshallian Demand:

$$\frac{\partial x_i}{\partial p_i} = \frac{\partial h_i}{\partial p_i}$$

- In this case, we get:

$$CV = EV = CS$$

Willig (1976)

- Dilemma: CS easier to compute but has no theoretical foundation and differs from CV and EV as soon as income elasticity is non-zero
- However in practice:
  difference between CS, EV and CV are usually smaller than error due to estimation, and small when the effect on welfare is small.
- Willig (1976): for $X \in \{EV, CV\}$

$$\frac{\eta^{\min}}{2} \cdot \frac{CS}{w} < \left| \frac{X - CS}{CS} \right| < \frac{\eta^{\max}}{2} \cdot \frac{CS}{w}$$

  where $\eta^{\min}$ and $\eta^{\max}$ are the min and max income elasticity of demand

$\Rightarrow$ Relative error $\left|\frac{X-CS}{CS}\right|$ is small with small shares in consumption $\frac{CS}{w}$

Comments on Willig (1976)

However, there are a number of reasons why the Willig result cannot always be used to justify the MCS as a good approximation to the CV and EV:

(1) The Willig result doesn't carry over to the multiple prices changes, assumptions not always satisfied

(2) Often we are trying to estimate the CS associated with a change in the prices and characteristics of some good or goods and/or a change in the level of non-market commodities, but the Willig result does not carry over to characteristics/non-market space (see Hanemann 1991, Shogrun et al 1994).

(3) There is no need to approximate. We can get the exact CS measures. This is most easily seen by appealing to duality theory.

Hausman (1981)

- Computes exact EV and CV (and DWL) rather than approximation
- Use Shephard's lemma and Roy's identity to retrieve Hicksian demand and expenditure function.

  Steps:

  1. Using Roy's identity, we can retrieve the indirect utility function (solve differential equation in $v(w, p)$)
  2. Invert the indirect utility to get the expenditure function: $v(e(u, p), p) = u$
  3. Obtain the Hicksian demand using Shephard's Lemma: $h_i(u, p) = \frac{\partial e(u,p)}{\partial p_i}$
  4. Use either the expenditure function or Hicksian demand to get CV or EV

- Note: Simple way = specify demand to estimate (e.g. CES) where the expenditure function can easily be computed from these estimates.

Consumer welfare with discrete-choice models

- The same tools can be used (McFadden 1978, 1981, Small Rosen 1981)
- Aggregating many consumers z with indirect utility across choices i:

$$U_z = \min_i \{\alpha(y - p_i) + \phi(Z_i) + \epsilon_{zi}\} = \min_i \{V_{zi} + \epsilon_{zi}\}$$

  with $\epsilon_{zi} \sim e^{-e^{-\epsilon}}$, we get:

$$EV = \int \frac{U_{zt'} - U_{zt}}{\alpha} dF(\epsilon) = \frac{1}{\alpha} \log \left(\frac{\sum_i \exp V_{zit'}}{\sum_i \exp V_{zit}} \right)$$

- But becomes quickly messing if we aggregate across consumers with heterogeneous α's interacting with many product characteristics Z_i

Plan

1. Tools
   - EV, CV
   - Consumer surplus
   - Price indexes
2. Illustrations

Ideal price index

- We've already seen Laspeyres and Paasche price indexes (using initial and new consumption as respective weights)

$$P^{Laspeyres} = \frac{x\,.\,p'}{x\,.\,p} \qquad P^{Paasche} = \frac{x'\,.\,p'}{x'\,.\,p}$$

- More generally, an **ideal** price index is defined as:

$$\text{Ideal Index} = \frac{e(p', u)}{e(p, u)} = Ideal(u)$$

- With homothetic preferences, $Ideal(u)$ does not depend on u

Comparison to Paasche and Laspeyres

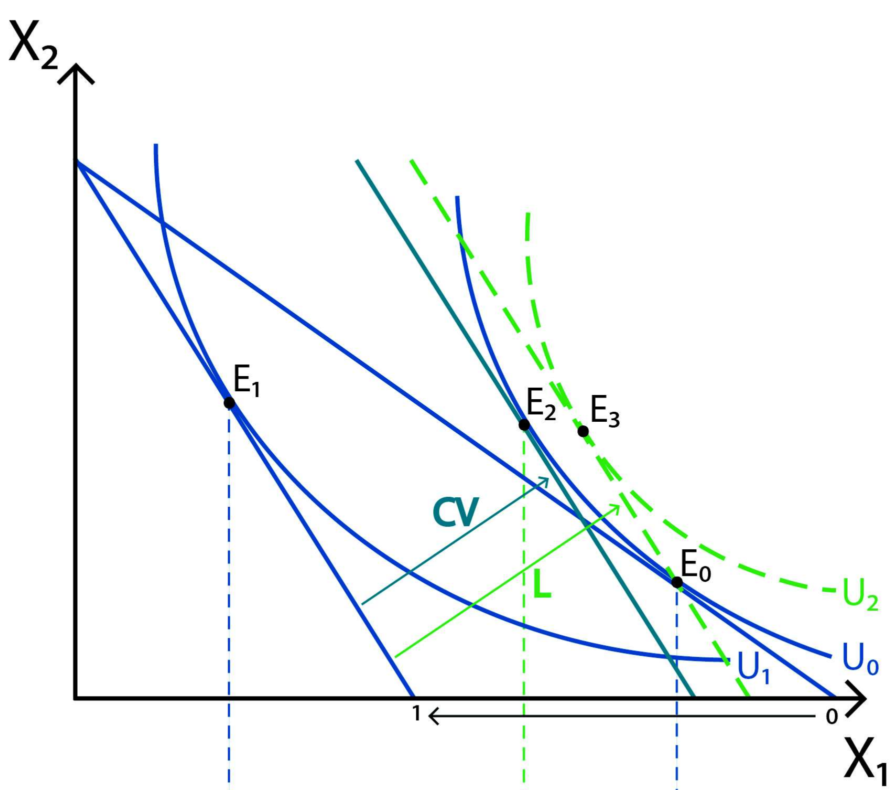
- Notice the "substitution bias":

$$P^{Laspeyres} = \frac{x \, . \, p'}{w} = \frac{x \, . \, p'}{e(p,u)} \geq \frac{e(p',u)}{e(p,u)} = Ideal(u)$$

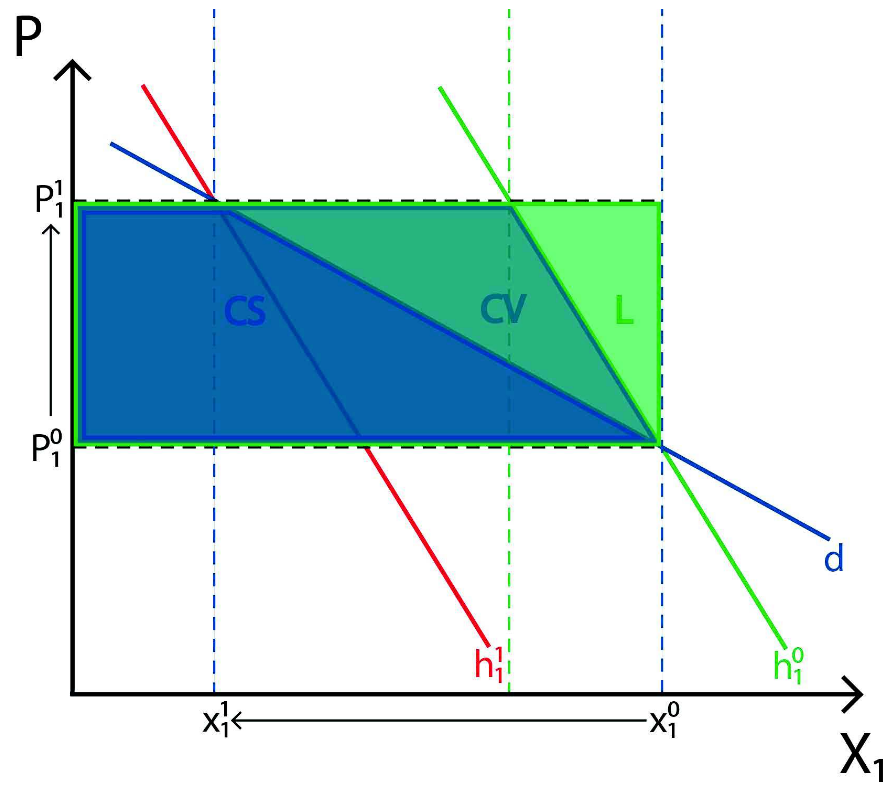
$$P^{Paasche} = \frac{w}{x' \, . \, p} = \frac{e(p',u')}{x' \, . \, p} \leq \frac{e(p',u')}{e(p,u')} = Ideal(u')$$

- Laspeyres and Paasche are ideal (or "exact") only for Leontief preferences
- We can show that: $P < EV < CS < CV < L$ for normal goods (graphical proof in the next slides)

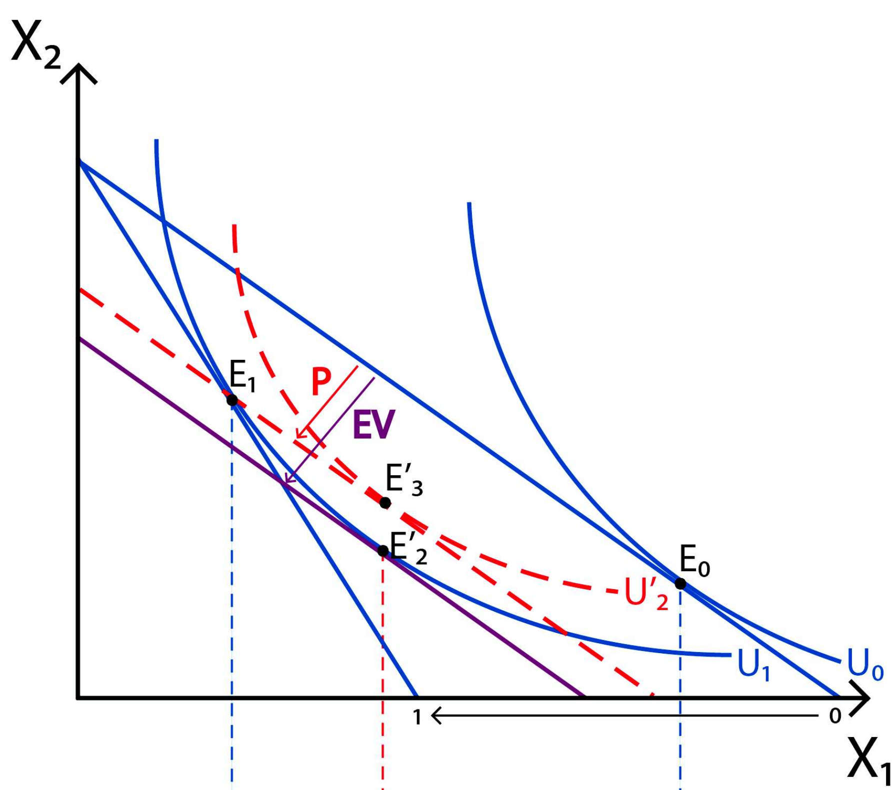
Compensating variation vs. Laspeyres price index, when price of good 1 increases:



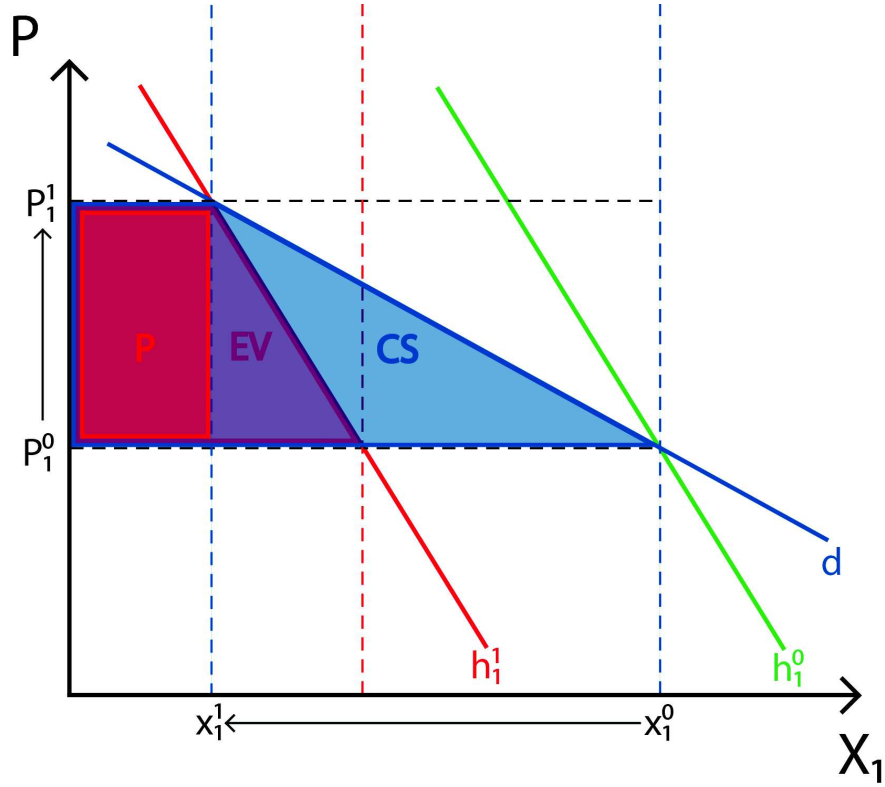
Compensating variation vs. Laspeyres price index



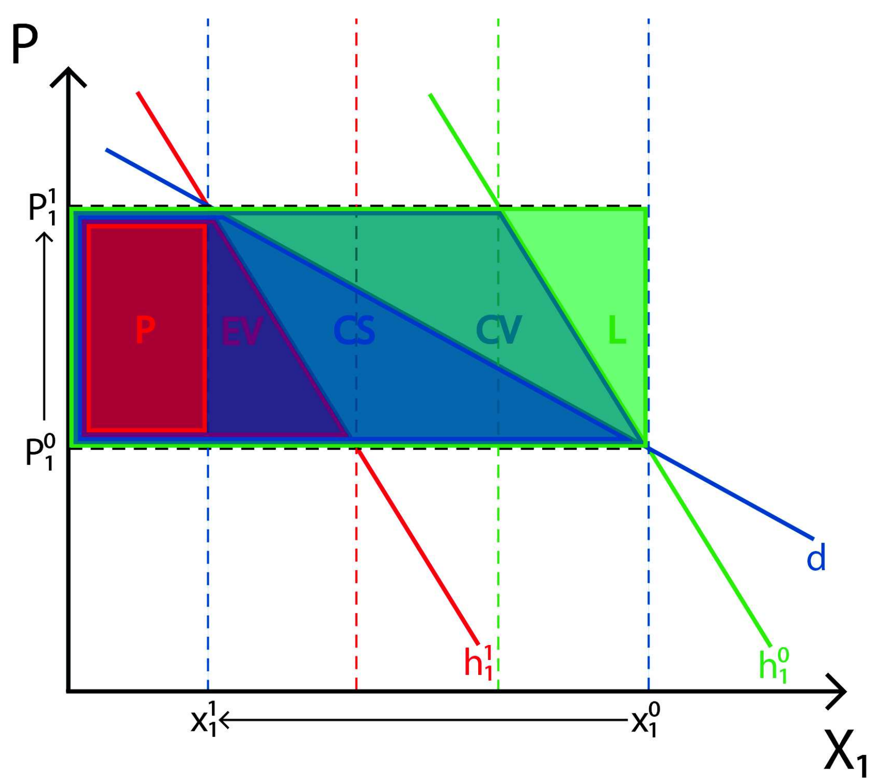
Equivalent variation vs. Paasche price index



Equivalent variation vs. Paasche price index



$P < EV < CS < CV < L$ for normal goods:



Simple example

With CES preferences $U = \left[\sum_i (b_i x_i)^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$

- Expenditure function: $e(U,p) = UP$, defining U as above and P as:
- CES ideal price index: $P = \left[\sum_i b_i^\sigma p_i^{1-\sigma}\right]$
- Equivalent variation: $EV = P.U' - w = (P - P').U'$
- Compensating variation: $CV = w - P'.U = (P - P').U$
- Generally, with homothetic preferences, it is easier and more direct to describe changes in price indexes P'/P than EV, CV and CS

More price indexes

- Fisher price index: geometric average of Paasche and Laspeyres

$$\log P^{Fisher} = \frac{1}{2}\left(\log P^{Laspeyres} + \log P^{Paasche}\right)$$

- Stone price index (using consumption shares s_{ti}, exact for CD prefs):

$$\log P^{Stone} = \sum_i s_{i1} \log\left(\frac{p_{i1}}{p_{i0}}\right)$$

- Tornqvist price index (frequently used, exact for translog preferences):

$$\log P^{Tornqvist} = \sum_i \left(\frac{s_{i1} + s_{i0}}{2}\right) \log\left(\frac{p_{i1}}{p_{i0}}\right)$$

\+ Various "tests" that price indexes should satisfy (Diewert 93)

Price indexes with CES

- CES ideal price index: $P = \left[\sum_i b_i^\sigma p_i^{1-\sigma}\right]$
  accounting for tastes parameters b_i (e.g. differences in quality)
  but σ is not directly observed (and hard to estimate)
- Sato-Vartia price index (exact for CES!)

$$\log P^{SV} = \sum_i w_i \log\left(\frac{p_{i1}}{p_{i0}}\right) \quad \text{with: } w_i = \frac{\left(\frac{s_{i1}-s_{i0}}{\ln s_{i1}-\ln s_{i0}}\right)}{\sum_j \left(\frac{s_{j1}-s_{j0}}{\ln s_{j1}-\ln s_{j0}}\right)}$$

Elements of proof: with CES: $\log s_i = \sigma \log b_i + (1-\sigma)(\log p_i - \log P)$. Summing over i with weights w_i to be determined, and taking the difference bw periods, we get: $\log\left(\frac{P_1}{P_0}\right) = \sum_i w_i \log\left(\frac{p_{i1}}{p_{i0}}\right) + \frac{1}{\sigma-1}\sum_i w_i \log\left(\frac{s_{i1}}{s_{i0}}\right)$. For $\sum_i w_i \log\left(\frac{p_{i1}}{p_{i0}}\right)$ to be a price index, we need $\sum_i w_i \log\left(\frac{s_{i1}}{s_{i0}}\right) = 0$. In the limit case $s_{i1} = s_{i0}$, we also need $w_i = s_i$.

Two other issues:

- **"Outlet bias"**:
  - We also need to account for variations in prices for the *same* good, and taking an average is not a good solution. Prices vary across out lets, consumers tend to buy in large quantities from cheap stores (e.g. Costco).
- **"New goods bias"**:
  - Price indexes above are based on comparison of prices before/after. With new goods: weights? prices?
  - More generally, there is a large literature aiming at quantifying the welfare gains from new goods, with various structures on the supply and demand side (see e.g. Hausman 2003, Nevo 2003)

New goods with CES

Q: How to account for new product varieties not available before?

- Feenstra (1994) extends SV to account for extensive margin:

$$P^{SV+} = \left(\frac{\sum_{i \in \Omega_c} s_{i1}}{\sum_{i \in \Omega_c} s_{i0}} \right)^{\frac{1}{\sigma - 1}} \times P^{SV}$$

  Across *continuing* varieties Ω_c, hence with $\sum_{i \in \Omega_c} s_{i1} < 1$

- See Problem Set 5 for simple case with homogeneous products

- Application: Broda and Weinstein (2006) estimate gains from increased import varieties (1972-2001) as 2.6% of GDP

Separability of expenditure function

- Suppose that we have two sets of goods: grocery vs. non-grocery

Q: Under which condition can we summarize the vector of prices p of grocery goods into a price index $P_G(p)$ such that consumption in non-grocery goods only depend on non-grocery prices and P_G?

A: If the expenditure function is separable, i.e. if we can write:

$$e(u, p, p') = \hat{e}(u, P_G(p), p')$$

where $P_G(p)$ is a grocery price index and p' vector of non-grocery prices

- Notes:
  - In this case: $\frac{h_i}{h_j} = \frac{\frac{\partial e}{\partial p_i}}{\frac{\partial e}{\partial p_j}} = \frac{\frac{\partial P_G}{\partial p_i}}{\frac{\partial P_G}{\partial p_j}}$ for any two grocery goods i and j
  - Separability in expenditure is neither sufficient or necessary for separability in utility

Plan

1. Tools

2. **Illustrations**

Welfare analysis in practice

Problem set 3 related to Cohen et al (2016) measuring CS for Uber

- PS3 highlights issues computing total CS rather than changes in CS
- Integrability issues given Cohen et al (2016)'s price elasticity estimates

Welfare analysis in practice

Atkin, Faber and Gonzalez (2016) as a good practical example.

- Foreign entry in the retail sector in Mexico, 2001-2014

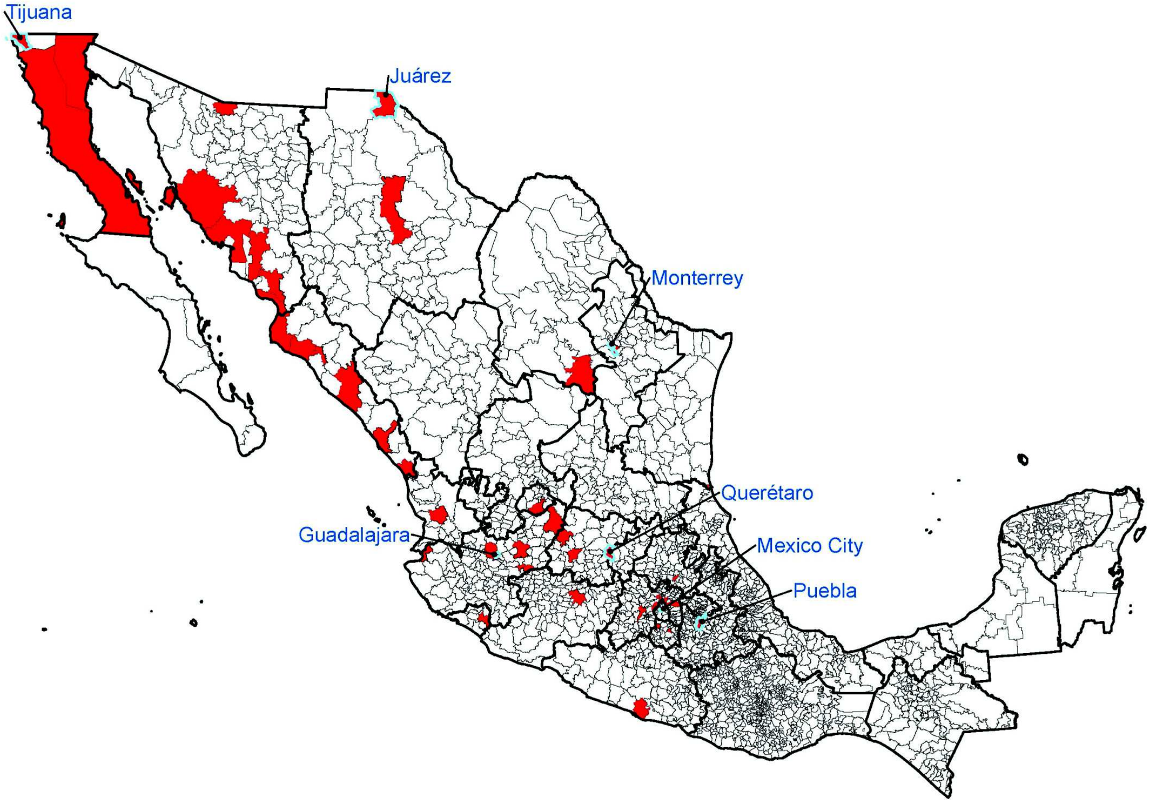
They mainly ask three questions:

1. What is the effect of foreign retail entry on household welfare?
2. What are the channels underlying this effect? (availability of new products, competition, entry/exit of local retailers, etc.)
3. Does the effect differ across the income distribution?

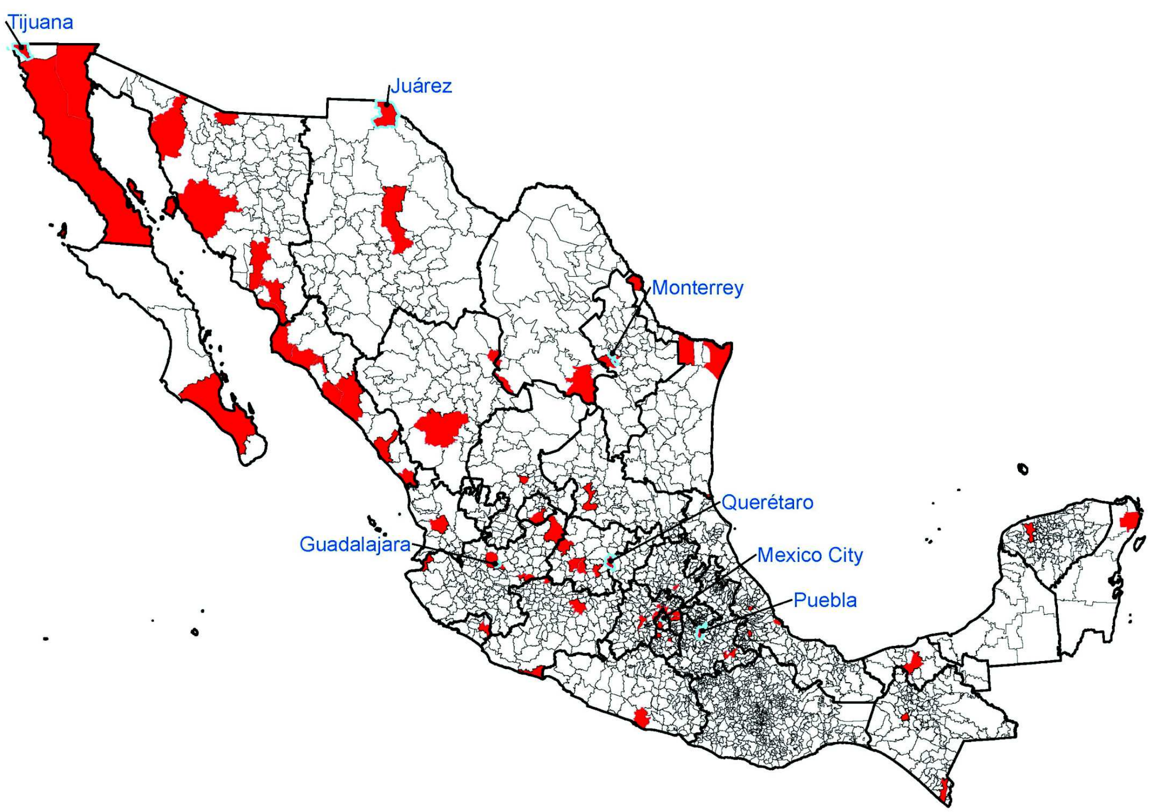
Motivation and context

- Intense policy debates in various countries:
  e.g. India hesitates to ban foreign entry in retail
- Retail in an important sector in developing economies:
  10-15% of GDP, $>$ 15% of employment, $>$ 50% expenditures
- Foreign retail FDI:
  Developing country share grew from 10% to 25% in two decades
- Large expansion of foreign retail in Mexico:
  From 365 stores in 2001 to 1335 stores in 2014.

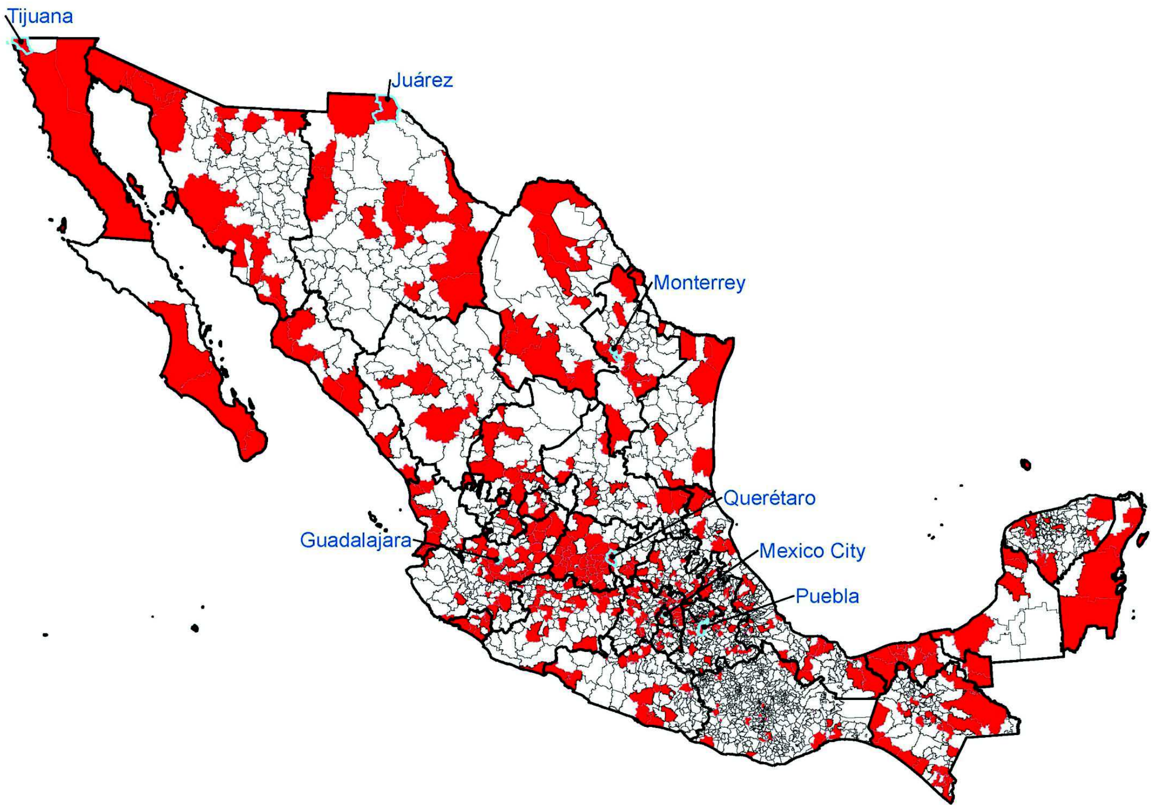
Localization of foreign stores – 204 stores in 1995



Localization of foreign stores – 365 stores in 2001



Localization of foreign stores – 1335 stores in 2014



Data

- Universe of supermarket locations, opening dates (2002-14)
- Barcode/store Mexican CPI microdata (2002-14) (INEGI)
- Household/barcode/store level Consumer Panel data (2011-14)
- ENIGH Household survey data on budget shares at product-group/store-type level (2006-12)
- Worker level data on income sources (2002-12)
- Store revenues, costs: Mexican Retail Census (2003 and 08)

How do foreign retailers differ *ex post*?

	(1)	(2)	(3)	(4)
Dependent Variable:	Log Price	Log Price	Log Number of Barcodes	Log Floor Space
Foreign Store Dummy	-0.118***	0.249***	1.612***	1.911***
	(0.00913)	(0.0160)	(0.0671)	(0.0416)
Municipality-By-Year FX	✓	✓	✓	✓
Municipality-By-Product-By-Month FX	✓	✓	×	×
Municipality-By-Barcode-By-Month FX	✓	×	×	×
Observations	18,659,777	18,659,777	10,393	11,113
R-squared	0.923	0.368	0.139	0.302
Number of Municipalities	151	151	151	499

Challenges

- Availability of consumption data (only available for later years at bar-code level) calls for Paasche indexes?
- Income effect: incomes may have changed due to foreign entry
  - Approx: neglect how changes in income affects substitution
- Price effects:
  - Direct negative effect on prices?
  - Differences in quality?
  - Entry / exit of stores and product variety?

General expression for welfare effects

- $CV = e(\mathbf{P}^1, u_h^0) - y_h^1$

$$= \underbrace{\left[e(\mathbf{P}^1, u_h^0) - e(\mathbf{P}^0, u_h^0)\right]}_{\text{Cost of living effect } (CLE)} - \underbrace{\left[y_h^1 - y_h^0\right]}_{\text{Income effect } (IE)}$$

- While effects on incomes can in principle be estimated without imposing additional structure, this is not the case for cost of living.
  - Can observe price changes of products in continuing domestic stores $(\mathbf{P}_{dc}^1 - \mathbf{P}_{dc}^0)$.
  - Cannot observe price changes for consumption at entering foreign retailers $(\mathbf{P}_f^1 - \mathbf{P}_f^{0*})$ or exiting domestic retailers $(\mathbf{P}_{dx}^{1*} - \mathbf{P}_{dx}^0)$.

A decomposition

$$CLE = \underbrace{\left[e(\mathbf{P}_{dc}^1, \mathbf{P}_{dx}^{1*}, \mathbf{P}_f^1, u_h^0) - e(\mathbf{P}_{dc}^1, \mathbf{P}_{dx}^{1*}, \mathbf{P}_f^{1*}, u_h^0)\right]}_{\text{1: Direct effect (DE)}} + \underbrace{\left[e(\mathbf{P}_{dc}^1, \mathbf{P}_{dx}^{1*}, \mathbf{P}_f^{1*}, u_h^0) - e(\mathbf{P}_{dc}^0, \mathbf{P}_{dx}^{0*}, \mathbf{P}_f^{0*}, u_h^0)\right]}_{\text{2: Pro-competitive intensive margin (PEI)}}$$
$$+ \underbrace{\left[e(\mathbf{P}_{dc}^0, \mathbf{P}_{dx}^{0*}, \mathbf{P}_f^{0*}, u_h^0) - e(\mathbf{P}_{dc}^0, \mathbf{P}_{dx}^0, \mathbf{P}_f^{0*}, u_h^0)\right]}_{\text{3: Pro-competitive exit margin (PEX)}}$$

$$IE = \underbrace{\sum_{i \in \{\tau, \mu\}} \left[l_{ih}^1 - l_{ih}^0\right]}_{\text{(4) Retail labor income effect}} + \underbrace{\sum_{i \in \{\tau, \mu\}} \left[\pi_{ih}^1 - \pi_{ih}^{i0}\right]}_{\text{(5) Retail profit effect}}$$
$$+ \underbrace{\sum_{i \in \{o\}} \left[(l_{ih}^1 - l_{ih}^0) + (\pi_{ih}^1 - \pi_{ih}^{i0})\right]}_{\text{(6) Other income effect}}$$

- Where *'s denote unobserved prices for products in entering/exiting retailers.

Two alternative approaches

1. Assuming multi-tier CES preferences:
   - Advantages: Exact price index, quantification of gains from new varieties
   - Disadvantages: Imposing structure on consumer preferences
2. First-order approximation:
   - Advantages: Paasche index as approximation without imposing specific preferences
   - Disadvantages: Holds post-entry market shares fixed, solely based on observed store price differences

     Assumes away gains from variety or shopping amenities

Using exact approach

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} : preferences within store-good unspecified for now

Under our multi-tier CES, the CLE becomes:

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

Notation

g=product group, s=store, b=barcode, m=municipality, t=month

$$r^t_{gsh}: \text{ Price index of product-specific prices } p^t_{gsb}$$

$$\phi^t_{gsh} = r^t_{gsh} q^t_{gsh} / \sum_{s\in S_g} r^t_{gsh} q^t_{gsh}$$

$$\tilde{\phi}^t_{gsh} = r^t_{gsh} q^t_{gsh} / \sum_{s\in S^{dc}_g} r^t_{gsh} q^t_{gsh}$$

$$\prod_{s\in S^{dc}_g} \left(\frac{r^1_{gsh}}{r^0_{gsh}}\right)^{\omega_{gsh}} : \text{ Sato-Vartia price index}$$

$$\omega_{gsh} = \left(\frac{\tilde{\phi}^1_{gsh} - \tilde{\phi}^0_{gsh}}{\ln \tilde{\phi}^1_{gsh} - \ln \tilde{\phi}^0_{gsh}}\right) / \sum_{s^{dc}\in S^{dc}_g} \left(\frac{\tilde{\phi}^1_{gsh} - \tilde{\phi}^0_{gsh}}{\ln \tilde{\phi}^1_{gsh} - \ln \tilde{\phi}^0_{gsh}}\right)$$

Using exact approach

Uses price changes and consumption basket changes to estimate (in particular: effect on (Stone) price index r_{gs} by store/product)

Uses preference parameters to estimate: η_{gh}

$$\frac{CV}{e(\mathbf{P}^0_d, \mathbf{P}^{0*}_f, u^0_h)} =$$

$$\underbrace{\left[\prod_{g\in G}\left\{\left(\frac{\sum_{s\in S^{dc}_g}\phi^1_{gsh}}{\sum_{s\in S^{dc}_g}\phi^0_{gsh}}\right)^{\frac{1}{\eta_{gh}-1}} \prod_{s\in S^{dc}_g}\left(\frac{r^1_{gs}}{r^0_{gs}}\right)^{\omega_{gsh}}\right\}^{\alpha_{gh}} - \prod_{g\in G}\left\{\left(\frac{1}{\sum_{s\in S^{dc}_g}\phi^0_{gsh}}\right)^{\frac{1}{\eta_{gh}-1}} \prod_{s\in S^{dc}_g}\left(\frac{r^1_{gs}}{r^0_{gs}}\right)^{\omega_{gsh}}\right\}^{\alpha_{gh}}\right]}_{\text{(1) Direct effect } (DE)}$$

$$+\underbrace{\left[\prod_{g\in G}\left\{\left(\frac{1}{\sum_{s\in S^{dc}_g}\phi^0_{gsh}}\right)^{\frac{1}{\eta_{gh}-1}} \prod_{s\in S^{dc}_g}\left(\frac{r^1_{gs}}{r^0_{gs}}\right)^{\omega_{gsh}}\right\}^{\alpha_{gh}} - \prod_{g\in G}\left\{\prod_{s\in S^{dc}_g}\left(\frac{r^1_{gs}}{r^0_{gs}}\right)^{\omega_{gsh}}\right\}^{\alpha_{gh}}\right]}_{\text{(3) Pro-competitive exit } (PEX)} + \underbrace{\left[\prod_{g\in G}\left\{\prod_{s\in S^{dc}_g}\left(\frac{r^1_{gs}}{r^0_{gs}}\right)^{\omega_{gsh}}\right\}^{\alpha_{gh}} - 1\right]}_{\text{(2) Pro-competitive price } (PEI)}$$

$$-\underbrace{\sum_{i\in\{\tau,\mu\}}\left[\theta^0_{ilh}\left(\frac{l^1_{ih}-l^0_{ih}}{l^0_{ih}}\right)\right]}_{\text{(4) Retail labor income effect}} - \underbrace{\sum_{i\in\{\tau,\mu\}}\left[\theta^0_{i\pi h}\left(\frac{\pi^1_{ih}-\pi^{i0}_{ih}}{\pi^0_{ih}}\right)\right]}_{\text{(5) Retail profit effect}} - \underbrace{\sum_{i\in\{o\}}\left[\theta^0_{ilh}\left(\frac{l^1_{ih}-l^0_{ih}}{l^0_{ih}}\right) + \theta^0_{i\pi h}\left(\frac{\pi^1_{ih}-\pi^{i0}_{ih}}{\pi^0_{ih}}\right)\right]}_{\text{(6) Other income effect}}$$

Using first-order general approach

Using Shephard's Lemma to approximate pro-competitive price effects (PP' below) and direct price effects (DE' below):

$$PP' \approx \sum_{b} \sum_{s \in S_b^{dc}} \left(q_{bsh}^1 (p_{bs}^1 - p_{bs}^0) \right)$$

$$\frac{PP'}{e(\mathbf{P}_f^1, \mathbf{P}_{dc}^1, \mathbf{P}_{dx}^{1*}, u_h^0)} \approx \sum_{b} \sum_{s \in S_b^{dc}} \left(\phi_{bsh}^1 \left(\frac{p_{bs}^1 - p_{bs}^0}{p_{bs}^1} \right) \right)$$

Similarly:

$$\frac{DE'}{e(\mathbf{P}_f^1, \mathbf{P}_{dc}^1, \mathbf{P}_{dx}^{1*}, u_h^0)} \approx \sum_{b} \sum_{s \in S_b^{f}} \left(\phi_{bsh}^1 \left(\frac{p_{bf}^1 - p_{bds}^0}{p_{bf}^1} \right) \right)$$

Using first-order general approach

Uses price changes to estimate

Holds ex post consumption shares constant ($\approx$ Paasche)

$$\frac{CV}{e(\mathbf{P}_d^0, \mathbf{P}_f^{0*}, u_h^0)} \approx \underbrace{\sum_{b} \sum_{s \in S_b^f} \left[\phi_{bsh}^1 \left(\frac{p_{bf}^1 - p_{bds}^0}{p_{bf}^1} \right) \right]}_{(1)\ \text{Direct effect}\ (DE)} + \underbrace{\sum_{b} \sum_{s \in S_b^{dc}} \left[\phi_{bsh}^1 \left(\frac{p_{bs}^1 - p_{bs}^0}{p_{bs}^1} \right) \right]}_{(2)\ \text{Pro-competitive effect}\ (PE)}$$

$$- \underbrace{\sum_{i \in \{\tau,\mu\}} \left[\theta_{ilh}^0 \left(\frac{l_{ih}^1 - l_{ih}^0}{l_{ih}^0} \right) \right]}_{(4)\ \text{Retail labor income effect}} - \underbrace{\sum_{i \in \{\tau,\mu\}} \left[\theta_{i\pi h}^0 \left(\frac{\pi_{ih}^1 - \pi_{ih}^{i0}}{\pi_{ih}^0} \right) \right]}_{(5)\ \text{Retail profit effect}} - \underbrace{\sum_{i \in \{o\}} \left[\theta_{ilh}^0 \left(\frac{l_{ih}^1 - l_{ih}^0}{l_{ih}^0} \right) + \theta_{i\pi h}^0 \left(\frac{\pi_{ih}^1 - \pi_{ih}^{i0}}{\pi_{ih}^0} \right) \right]}_{(6)\ \text{Other income effect}}$$

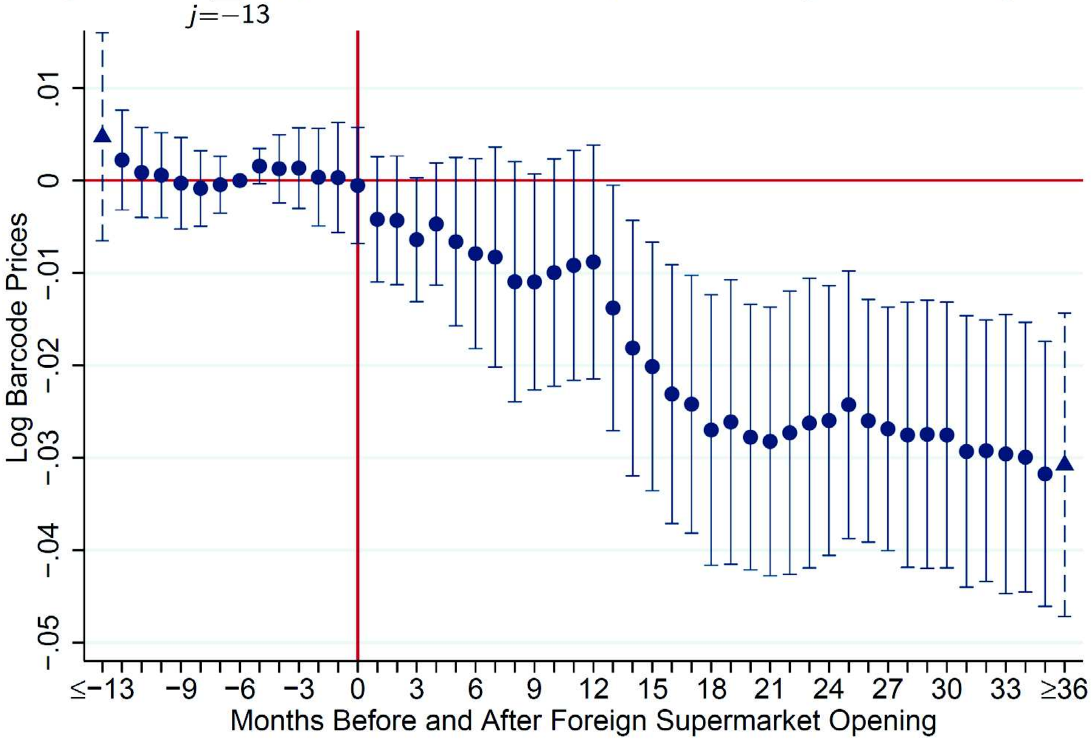
What we need to estimate

- Estimate direct effect on prices $\frac{r_{gs}^1}{r_{gs}^0}$
- Differences in prices across stores $p_{bf}^1 - p_{bds}^0$
- Effect on quantities
- Effect on the number of local stores
- Effect on income, by source (retail labor, retail profits, other)
- CES preferences: estimate elasticity of substitution η_{gh}

Notation:
g=product group, s=store, b=barcode, m=municipality, t=month

Direct effect on prices

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

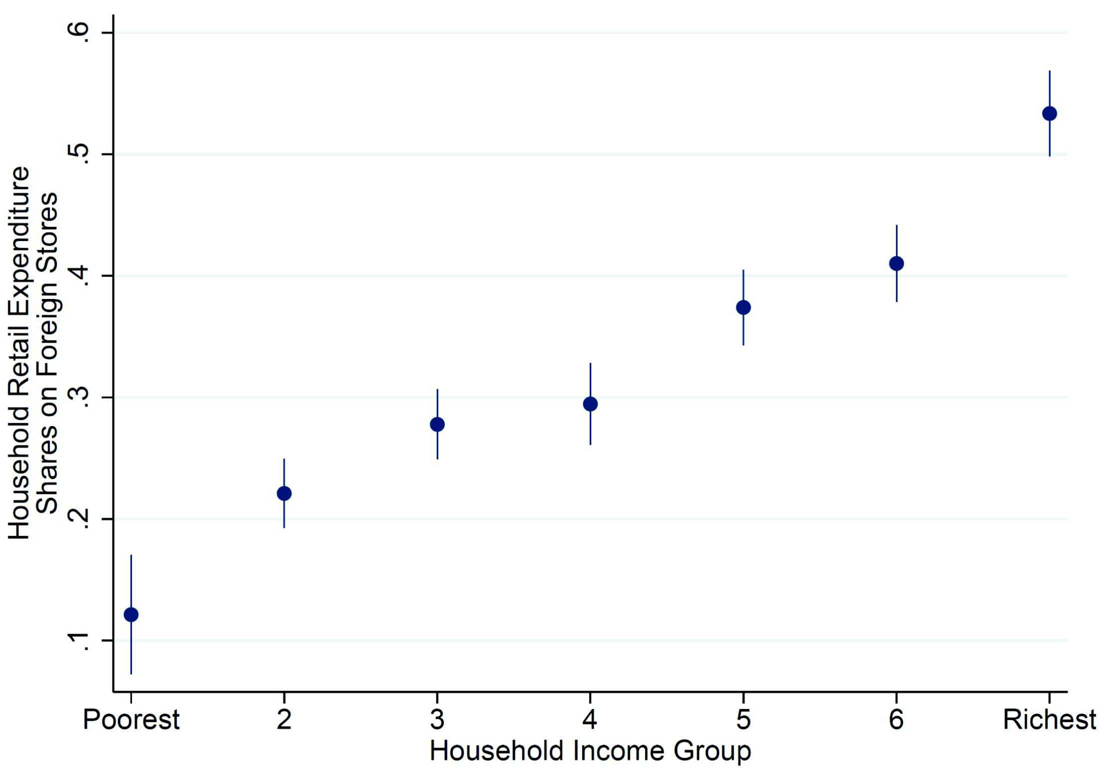


Differences in prices across stores

(to be used for first-order approximation)

Dependent Variable:	(1) Log Price	(2) Log Price	(3) Log Price	(4) Log Price
Domestic Store	0.118***			
	(0.00913)			
Domestic Store X Food		0.124***		
		(0.00979)		
Domestic Store X Non-Food		0.0744***		
		(0.00765)		
Domestic Store X Traditional			0.173***	
			(0.00874)	
Domestic Store X Modern			0.0397***	
			(0.0113)	
Domestic Store X Food X Traditional				0.174***
				(0.00942)
Domestic Store X Non-Food X Traditional				0.170***
				(0.0108)
Domestic Store X Food X Modern				0.0431***
				(0.0124)
Domestic Store X Non-Food X Modern				0.0189***
				(0.00713)
Municipality-By-Barcode-By-Month FX	✓	✓	✓	✓
Observations	18,659,777	18,659,777	18,659,777	18,659,777
R-squared	0.923	0.923	0.923	0.923
Number of Municipalities	151	151	151	151

Ex post foreign retail share by income group



Effect on store exit

$$dln\left(N\_Establishments_m^{08-03}\right) = \beta_1 ForeignEntry_m^{08-03} + \beta_2 ForeignEntry_m^{Pre\ 04} + \gamma X_m + \varepsilon_m$$

Panel A: Unweighted regressions	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	ΔLog(Number Stores) 2003-08 Traditional Store Formats				ΔLog(Number Stores) 2003-08 Modern Store Formats			
ΔForeign Entry 2003-2008	-0.019	-0.023	-0.025*	-0.024*	0.0088	-0.0065	-0.036	-0.035
	(0.014)	(0.014)	(0.014)	(0.014)	(0.067)	(0.068)	(0.069)	(0.069)
Foreign Entry Pre 2003	-0.055***	-0.057***	-0.035**	-0.032**	0.20***	0.16***	0.17***	0.17***
	(0.013)	(0.015)	(0.015)	(0.016)	(0.053)	(0.058)	(0.060)	(0.062)
Δlog(Public Expenditures)			0.12***	0.12***			0.37***	0.38***
			(0.028)	(0.028)			(0.12)	(0.12)
Δlog(GDP per Capita)				-0.020				-0.012
				(0.014)				(0.066)
Geographical Region FX	×	✓	✓	✓	×	✓	✓	✓
Municipality Size FX	×	✓	✓	✓	×	✓	✓	✓
Observations	608	608	564	564	608	608	564	564
R-squared	0.022	0.056	0.107	0.110	0.015	0.085	0.107	0.107
Median Stores/Municipality	2088	2088	2088	2088	33.5	33.5	33.5	33.5

Effect on income

No effect on average income (see paper), but some heterogeneity:

$$\ln(Income)_{jimt} = \sum_i \beta_i \left(ForeignEntry_{mt} \times Occupation_i\right) + \gamma X_{jimt} + \delta_{mt} + \eta_{im} + \theta_{it} + \varepsilon_{jimt}$$

Dependent Variable:	(1) Log (Monthly Income)	(2) Log (Monthly Income)	(3) Log (Monthly Income)	(4) Log (Employment)	(5) Log (Employment)	(6) Log (Employment)
Foreign Entry X Modern Retail Workers	-0.000278	-0.0348*	-0.0278	-0.00396	0.0369	0.0392
	(0.0192)	(0.0204)	(0.0212)	(0.0653)	(0.0714)	(0.0561)
Foreign Entry X Traditional Retail Workers	-0.0356*	-0.0571***	-0.0592**	-0.104*	-0.0942	-0.113**
	(0.0199)	(0.0216)	(0.0240)	(0.0531)	(0.0571)	(0.0552)
Foreign Entry X Agriculture	0.0265	0.0218	0.0202	-0.0597	-0.0285	-0.00811
	(0.0264)	(0.0311)	(0.0307)	(0.0809)	(0.101)	(0.106)
Foreign Entry X Manufacturing	-0.00513	-0.00612	0.0117	-0.166***	0.00572	-0.0166
	(0.0174)	(0.0186)	(0.0187)	(0.0379)	(0.0368)	(0.0380)
Person Controls	✓	✓	✓	×	×	×
Municipality-by-Quarter FX	✓	✓	✓	✓	✓	✓
Municipality-by-Group Fixed Effects	✓	✓	✓	✓	✓	✓
Group-by-Quarter FX	×	✓	✓	×	✓	✓
State-by-Group Time Trends	×	×	✓	×	×	✓
Observations	3,878,561	3,878,561	3,878,561	47,666	47,666	47,666
R-squared	0.340	0.340	0.341	0.963	0.965	0.967
Number of Individuals	1,455,911	1,455,911	1,455,911	1,455,911	1,455,911	1,455,911
Number of Municipality-by-Quarter Cells	8,574	8,574	8,574	8,574	8,574	8,574
Number of State-by-Group Time Trends	160	160	160	160	160	160
Number of Municipality Clusters	273	273	273	273	273	273

Using exact approach

Uses price changes and consumption basket changes to estimate

Uses preference parameters to estimate: η_{gh}

$$\frac{CV}{e(\mathbf{P}_d^0, \mathbf{P}_f^{0*}, u_h^0)} =$$

$$\underbrace{\left[\prod_{g\in G}\left\{\left(\frac{\sum_{s\in S_g^{dc}}\phi_{gsh}^1}{\sum_{s\in S_g^{dc}}\phi_{gsh}^0}\right)^{\frac{1}{\eta_{gh}-1}}\prod_{s\in S_g^{dc}}\left(\frac{r_{gs}^1}{r_{gs}^0}\right)^{\omega_{gsh}}\right\}^{\alpha_{gh}} - \prod_{g\in G}\left\{\left(\frac{1}{\sum_{s\in S_g^{dc}}\phi_{gsh}^0}\right)^{\frac{1}{\eta_{gh}-1}}\prod_{s\in S_g^{dc}}\left(\frac{r_{gs}^1}{r_{gs}^0}\right)^{\omega_{gsh}}\right\}^{\alpha_{gh}}\right]}_{(1)\ \text{Direct effect}\ (DE)}$$

$$+\underbrace{\left[\prod_{g\in G}\left\{\left(\frac{1}{\sum_{s\in S_g^{dc}}\phi_{gsh}^0}\right)^{\frac{1}{\eta_{gh}-1}}\prod_{s\in S_g^{dc}}\left(\frac{r_{gs}^1}{r_{gs}^0}\right)^{\omega_{gsh}}\right\}^{\alpha_{gh}} - \prod_{g\in G}\left\{\prod_{s\in S_g^{dc}}\left(\frac{r_{gs}^1}{r_{gs}^0}\right)^{\omega_{gsh}}\right\}^{\alpha_{gh}}\right]}_{(3)\ \text{Pro-competitive exit}\ (PEX)} + \underbrace{\left[\prod_{g\in G}\left\{\prod_{s\in S_g^{dc}}\left(\frac{r_{gs}^1}{r_{gs}^0}\right)^{\omega_{gsh}}\right\}^{\alpha_{gh}} - 1\right]}_{(2)\ \text{Pro-competitive price}\ (PEI)}$$

$$-\underbrace{\sum_{i\in\{\tau,\mu\}}\left[\theta_{ilh}^0\left(\frac{l_{ih}^1 - l_{ih}^0}{l_{ih}^0}\right)\right]}_{(4)\ \text{Retail labor income effect}} - \underbrace{\sum_{i\in\{\tau,\mu\}}\left[\theta_{i\pi h}^0\left(\frac{\pi_{ih}^1 - \pi_{ih}^{i0}}{\pi_{ih}^0}\right)\right]}_{(5)\ \text{Retail profit effect}} - \underbrace{\sum_{i\in\{o\}}\left[\theta_{ilh}^0\left(\frac{l_{ih}^1 - l_{ih}^0}{l_{ih}^0}\right) + \theta_{i\pi h}^0\left(\frac{\pi_{ih}^1 - \pi_{ih}^{i0}}{\pi_{ih}^0}\right)\right]}_{(6)\ \text{Other income effect}}$$

Price elasticity of demand

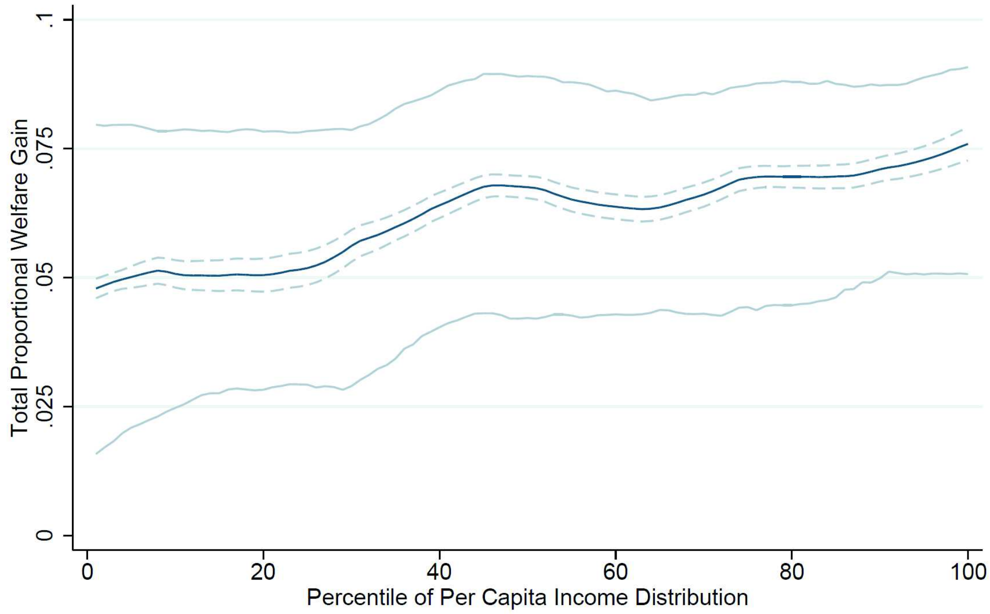
It's a challenge to get large enough elasticities η_{gh}:

$$\ln\phi_{gshmt} = (1-\eta_{gh})\ln r_{gshmt} - (1-\eta_{gh})\ln c_{ghmt} + \eta_{gh}\ln\beta_{gshmt}$$

Panel A: Average Coefficient Estimates	(1)	(3)	(5)	(7)	(9)
Dependent Variable: Log Budget Shares (Phi)	Average Prices OLS	Average Prices National IV	Average Prices Regional IV	Average Prices National IV	Average Prices Regional IV
Log(Store Price Index)	0.214***	-1.341***	-1.856***	-2.648***	-3.362***
	(0.006)	(0.145)	(0.608)	(0.338)	(1.038)
Product Group-by-Income Group-by-Municipality-by-Quarter FX	✓	✓	✓	✓	✓
Retailer-by-Product Group-by-Quarter FX	✓	✓	✓	✓	✓
Retailer-by-Municipality FX	✓	✓	✓	✓	✓
Retailer-by-Municipality-by-Quarter FX	×	×	×	✓	✓
Retailer-by-Municipality-by-Product Group FX	×	×	×	×	×
Observations	304,885	304,885	297,624	304,885	297,624
First-Stage F-Statistic		184.884	14.833	87.951	15.52

Welfare gains with CES

Distribution of the Gains from Retail FDI



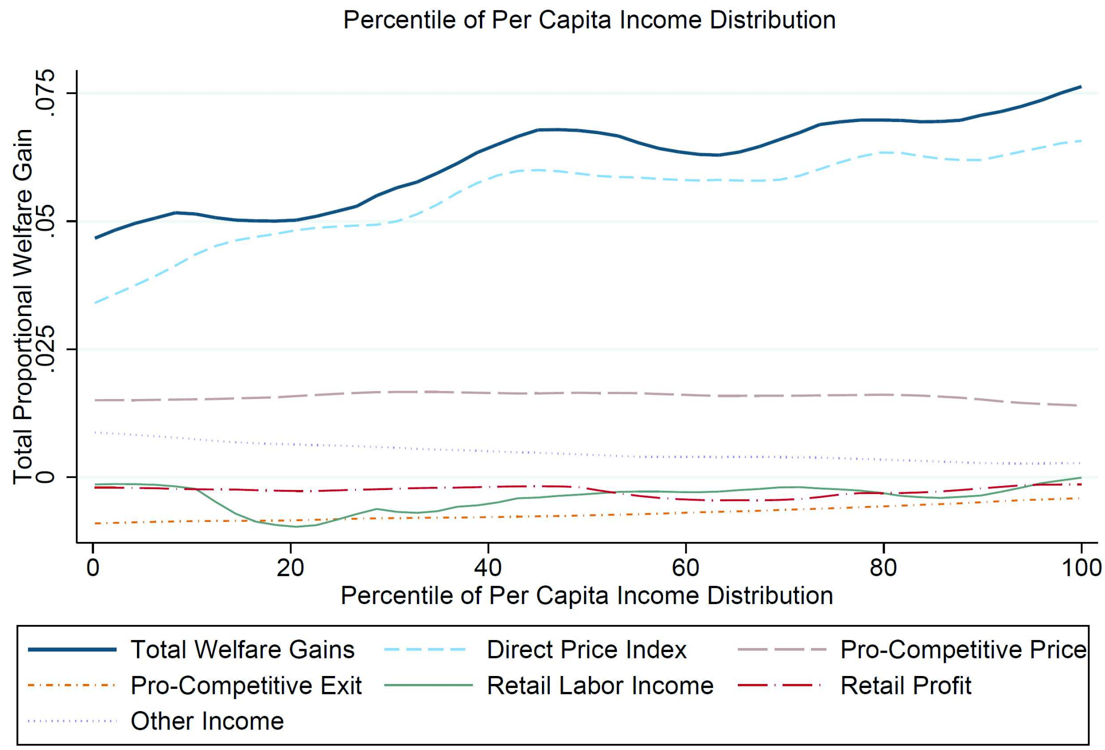
- Large and significant average gains from foreign entry.
- Gains are regressive (richest gain approximately 1.5 times as much).

Welfare gains with CES

Decomposition of the 6.2% average welfare gains:
- most of the gains from cost of living effect (CLE)
- 3/4 direct effect (lower prices, higher quality at foreign stores)
- 1/4 driven by pro-competitive effects on domestic stores

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				Exact Under CES Approach			
Dependent Variable:	Total Effect	Direct Price Index Effect	Pro-Comp Price Effect	Pro-Comp Exit	Labor Income Effect	Profit Effect	Other Income Effect
Average Effect	0.0621***	0.0551***	0.0158***	-0.00705	-0.00397**	-0.00269**	0.0049
	(0.0104)	(0.0006)	(0.0050)	(0.0053)	(0.0020)	(0.0013)	(0.0078)
Max	0.730	0.177	0.055	0.000	0.692	0.000	0.020
Min	-0.986	0.000	0.000	-0.014	-1.000	-1.000	0.000
Proportion Negative	0.0203	0	0	0.999	0.0736	0.0581	0
Observations (Households)	12,293	12,293	12,293	12,293	12,293	12,293	12,293
Number of Municipality Clusters	240	240	240	240	240	240	240

Welfare gains with CES



Using first-order general approach

Uses price changes to estimate

Holds ex post consumption shares constant ($\approx$ Paasche)

$$\frac{CV}{e(\mathbf{P}_d^0,\mathbf{P}_f^{0*},u_h^0)} \approx \underbrace{\sum_b \sum_{s\in S_b^f}\left[\phi_{bsh}^1\left(\frac{p_{bf}^1-p_{bds}^0}{p_{bf}^1}\right)\right]}_{(1)\ \text{Direct effect}\ (DE)} + \underbrace{\sum_b\sum_{s\in S_b^{dc}}\left[\phi^1_{bsh}\left(\frac{p^1_{bs}-p^0_{bs}}{p^1_{bs}}\right)\right]}_{(2)\ \text{Pro-competitive effect}\ (PE)}$$

$$-\underbrace{\sum_{i\in\{\tau,\mu\}}\left[\theta^0_{ilh}\left(\frac{l^1_{ih}-l^0_{ih}}{l^0_{ih}}\right)\right]}_{(4)\ \text{Retail labor income effect}} - \underbrace{\sum_{i\in\{\tau,\mu\}}\left[\theta^0_{i\pi h}\left(\frac{\pi^1_{ih}-\pi^{i0}_{ih}}{\pi^0_{ih}}\right)\right]}_{(5)\ \text{Retail profit effect}} - \underbrace{\sum_{i\in\{o\}}\left[\theta^0_{ilh}\left(\frac{l^1_{ih}-l^0_{ih}}{l^0_{ih}}\right)+\theta^0_{i\pi h}\left(\frac{\pi^1_{ih}-\pi^{i0}_{ih}}{\pi^0_{ih}}\right)\right]}_{(6)\ \text{Other income effect}}$$

Lower estimated gains with first-order approximation

- No effect of exit (using ex post consumption shares)
- Smaller direct effect (neglects quality $\neq$ bw domestic vs foreign stores)
- Smaller pro-competitive effects (neglects quality upgrading)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Exact Under CES Approach						
Dependent Variable:	Total Effect	Direct Price Index Effect	Pro-Comp Price Effect	Pro-Comp Exit	Labor Income Effect	Profit Effect	Other Income Effect
Average Effect	0.0621***	0.0551***	0.0158***	-0.00705	-0.00397**	-0.00269**	0.0049
	(0.0104)	(0.0006)	(0.0050)	(0.0053)	(0.0020)	(0.0013)	(0.0078)
	(8)	(9)	(10)	(11)	(12)	(13)	(14)
	First Order Approach						
Dependent Variable:	Total Effect	Direct Price Index Effect	Pro-Comp Price Effect	Pro-Comp Exit	Labor Income Effect	Profit Effect	Other Income Effect
Average Effect	0.0295***	0.0204***	0.0109***	0	-0.00397**	-0.00269**	0.0049
	(0.0093)	(0.0014)	(0.0037)	(0.0000)	(0.0020)	(0.0013)	(0.0078)
Max	0.715	0.060	0.031	0.000	0.692	0.000	0.020
Min	-0.995	0.000	0.000	0.000	-1.000	-1.000	0.000
Proportion Negative	0.0527	0	0	0	0.0736	0.0581	0
Observations (Households)	12,293	12,293	12,293	12,293	12,293	12,293	12,293
Number of Municipality Clusters	240	240	240	240	240	240	240

Concluding remarks

- Large positive effects of foreign entry in retail sector
  (6.2% gains on average for Mexican households)
- Gains 50% larger for rich consumers
  (see paper for decompositions of these differences in gains)
- Mostly driven by effects on cost of living
  Small effects on income, affects only a minority
- Quality of stores and products matter quantitatively:
  important to account for it (e.g. with CES exact price indexes)