Product Introductions, Currency Unions, and the Real Exchange Rate

Alberto Cavallo
MIT

Brent Neiman
University of Chicago

Roberto Rigobon
MIT

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Motivation

- Classic theories of the real exchange rate (RER) assume traded goods adhere to the "Law of One Price" (LOP)
- Big literature shows LOP fails among traded goods (Engel 1999; Crucini et al. 2005; Gopinath et al. AER 2011)
- Understanding international relative prices matters for behavior of RER shocks

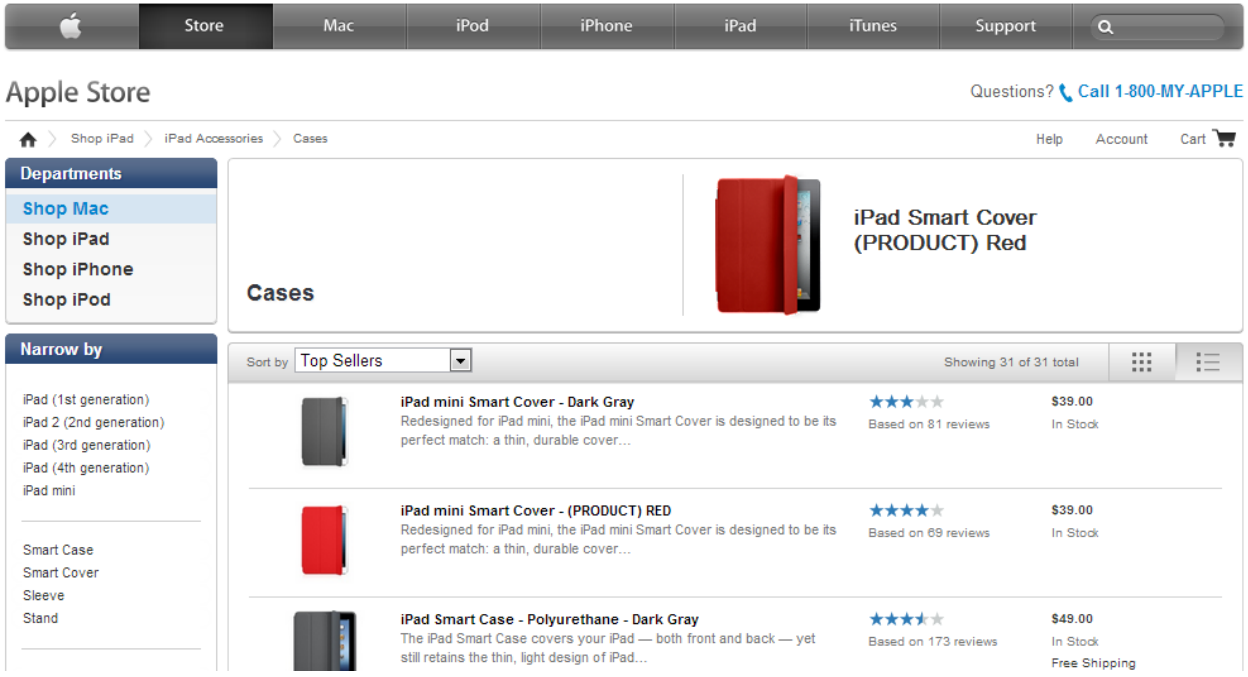
What We Do

1. Introduce large dataset of identical tradeable goods, sold by global retailers in three industries and dozens of countries.
2. LOP generally holds within Currency Unions, fails otherwise (including pegged regimes).
3. New decomposition shows RER at time of introduction is most important component of RER and moves closely with NER.

Price Data from Four Global Retailers

- Apple, IKEA, Zara, and H&M
- Among the largest global retailers (by sales) in technology, furniture, and apparel industries
- Headquartered in different countries, not jointly owned or related.
- Prices "scraped" off the retailer websites (eg. `http://store.apple.com/us/browse/home/shop_ipad/ipad_accessories/cases`)

How Does "Scraping" Work?




```
<html>
<!-- START product -->
<ahref="productId=MD963LL"></a>
<p class="productname">Ipad Mini Smart Cover – Dark Grey</p>
<td class="Price">$39.00</td>
<!-- END product -->
.....
```

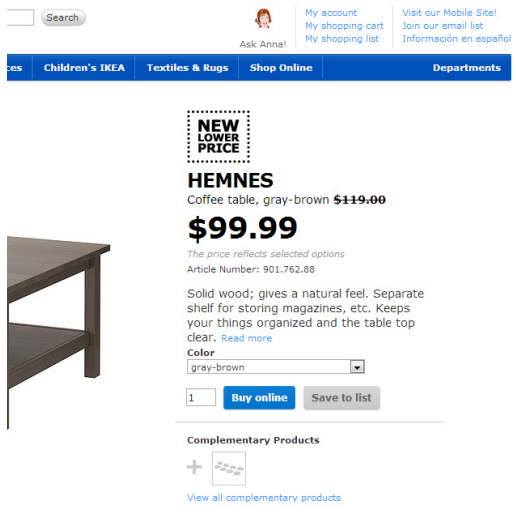
- Automatically detects product introductions

▸ Other Advantages

Online Prices

- Weekly prices for $\sim$ 90K goods in 81 countries, from 2008 to 2012 (countries and time period vary for each retailer) Details
- Match identical products using retailer-specific id codes (larger overlap than UPCs, many countries)
- No price dispersion within-countries. Single retailer for each good.
- Prices include VAT taxes (US/Can are exceptions). Not within-country shipping costs. No info on quantities sold.
- Online and offline prices are identical. Confirmed with customer service and doing physical checks in each of these stores.

Online Prices Equal Offline Prices



(a) IKEA Online

(b) IKEA in Store

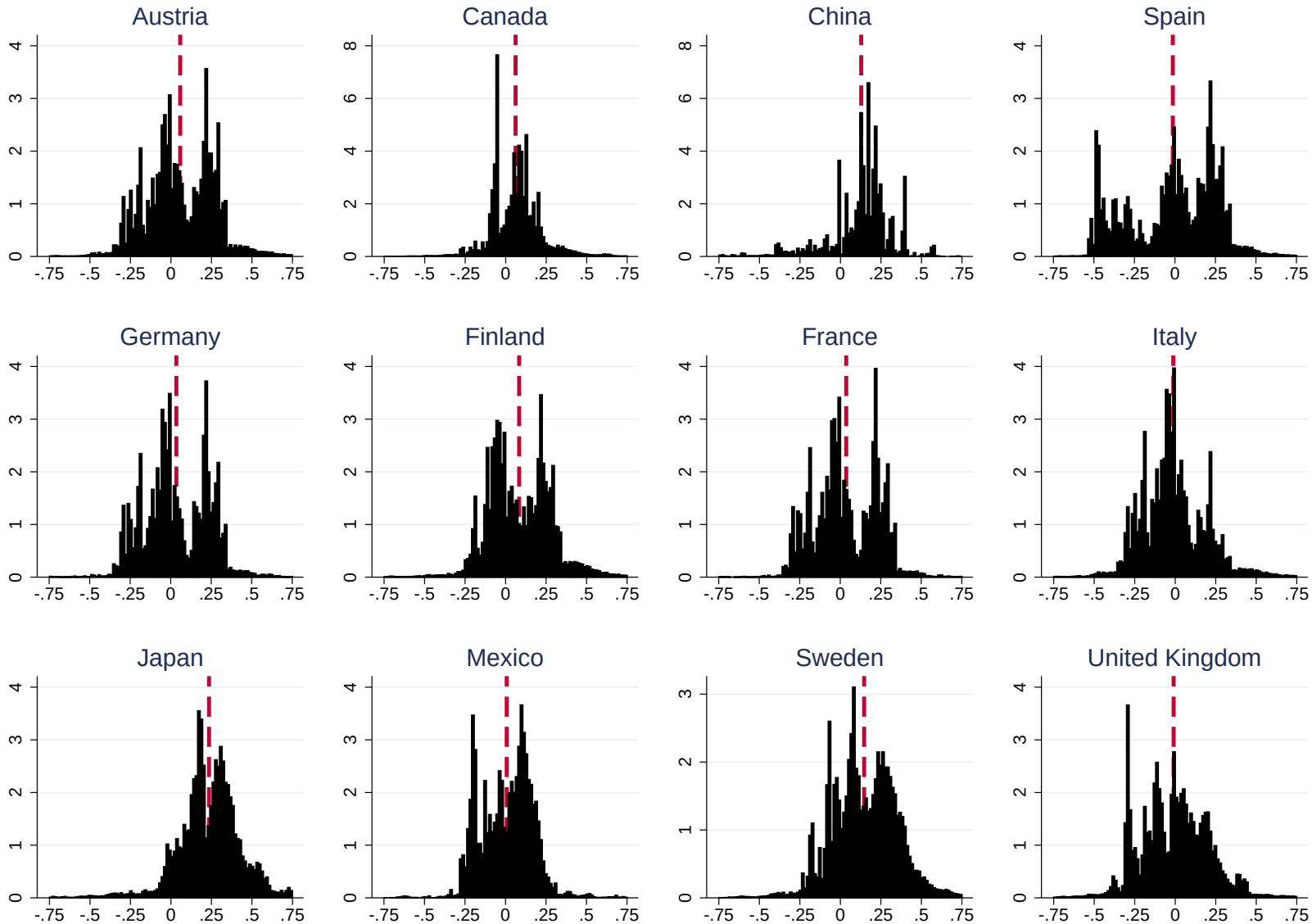
Good-level RER Definition

- $p_i(z,t)$ is log price of z in country i in week t
- $e_{ij}(t)$ is log exchange rate (units of currency i per unit of j's)
- $q_{ij}(z,t)$ is the log of the good-level RER:

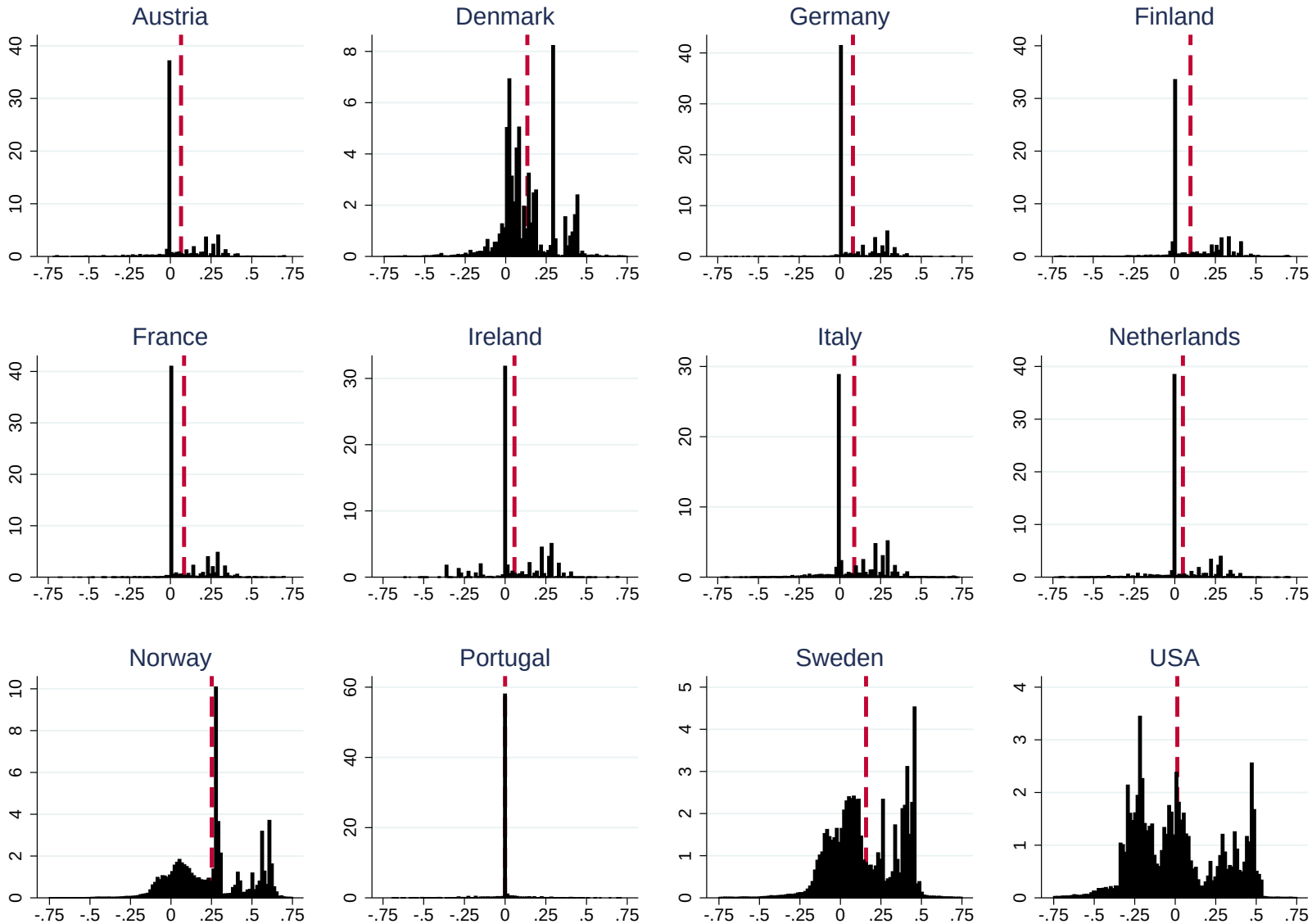
$$q_{ij}(z,t) = p_i(z,t) - e_{ij}(t) - p_j(z,t)$$

- $q_{ij}(z,t) = 0$ when the LOP holds

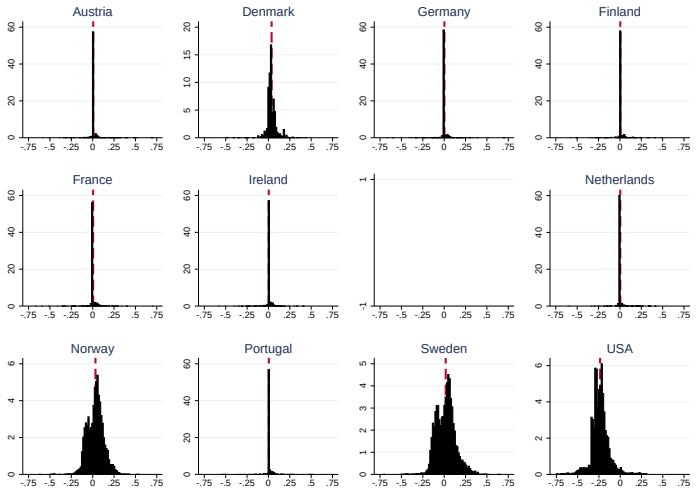
Good-level RERs q_{ij} for j = United States



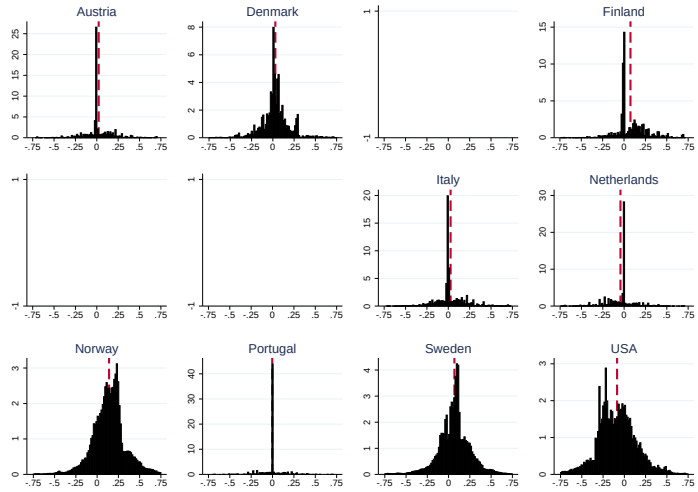
Good-level RERs q_{ij} for j = Spain



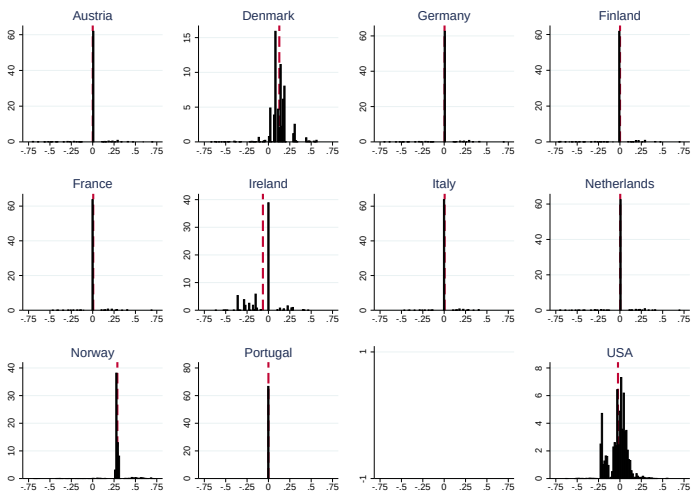
Good-level RERs q_{ij} for j = Spain, by Store



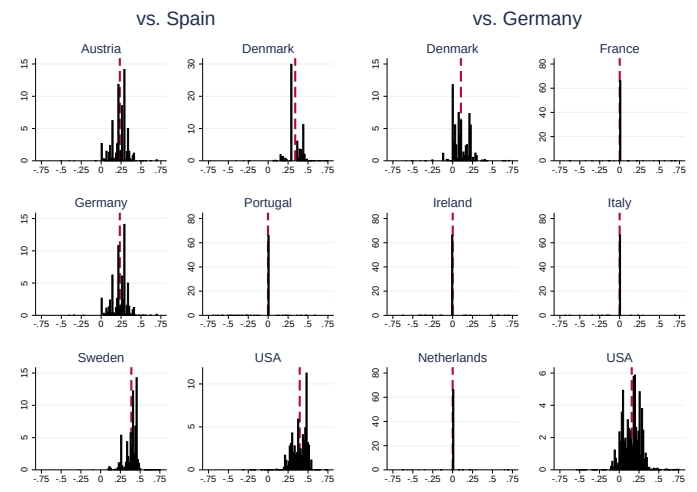
(a) Apple



(b) IKEA



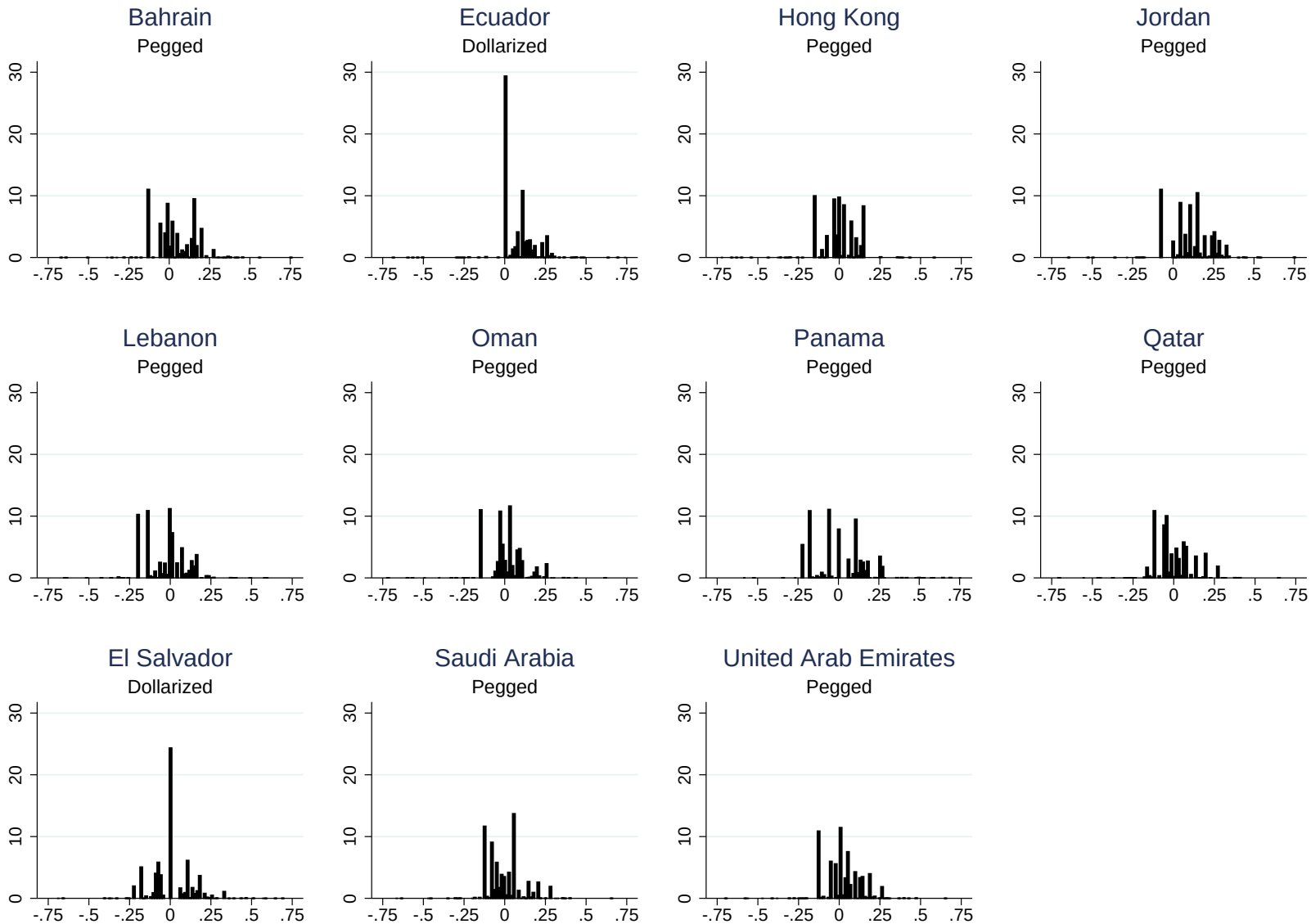
(c) H&M



(d) Zara

Currency Unions or the Euro Zone?

Zara only. Some countries have no online sales.



Unconditional Averages

Average Absolute Value of Good-Level Log RER

		All Stores	**Apple**	**IKEA**	**H&M**	**Zara**
All Data	Currency Unions	0.062	0.005	0.117	0.021	0.087
All Data	NER Pegs	0.149	0.047	0.164	0.141	0.142
All Data	Floats	0.182	0.139	0.185	0.152	0.192

▸ Regression Results

Results

- Result 1 : LOP holds well within currency unions ($q \approx 0$)
  - Single currency is more important for market segmentation than geography, culture, or tariffs.
  - Does not hold for hard pegs, so LOP is not just about lack of NER volatility.

- Result 2: We now introduce an RER decomposition
  - How much of the LOP deviation comes at the time of product introduction, is due to subsequent price changes, or stickiness with NER volatility?

RER Decomposition

- Let $i_i(z)$ be the t at which good z is first available in i
- Let $l_i(z,t)$ be the most recent t when z changed price in i
- Let $\bar{p}_i(z) = p_i(z, i_i(z))$ be the log price at introduction
- We can then write the price of z in i at t as:

$$p_i(z,t) = \bar{p}_i(z) + \Delta_{i_i(z)}^{l_i(z,t)} p_i(z)$$

RER Decomposition

- Re-write this when translated into country k currency units:

$$p_i(z,t) - e_{ik}(t) = \underbrace{\bar{p}_i(z) - e_{ik}(i_i(z))}_{\text{Price at Introduction}} + \underbrace{\Delta_{i_i(z)}^{l_i(z,t)}\left(p_i(z) - e_{ik}\right)}_{\text{Price Changes}} - \underbrace{\Delta_{l_i(z,t)}^{t} e_{ik}}_{\text{Stickiness}}$$

- Combining with equivalent expression for $p_j(z,t) - e_{jk}(t)$:

$$q_{ij}(z,t) = \underbrace{\bar{p}_i(z) - e_{ik}(i_i(z)) - \bar{p}_j(z) + e_{jk}(i_j(z))}_{\text{Good-Level RER at Introduction}}$$

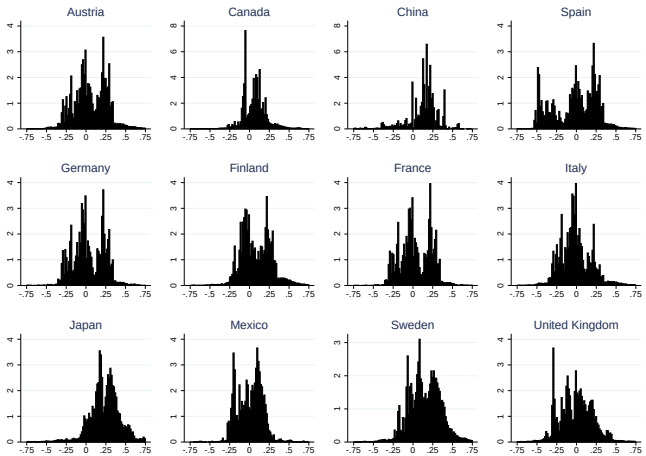
$$+ \underbrace{\Delta_{i_i(z)}^{l_i(z,t)}\left(p_i(z) - e_{ik}\right) - \Delta_{i_j(z)}^{l_j(z,t)}\left(p_j(z) - e_{jk}\right)}_{\text{Changes in Demand}} - \underbrace{\left[\Delta_{l_i(z,t)}^{t} e_{ik} - \Delta_{l_j(z,t)}^{t} e_{jk}\right]}_{\text{Stickiness}}$$

RER Decomposition

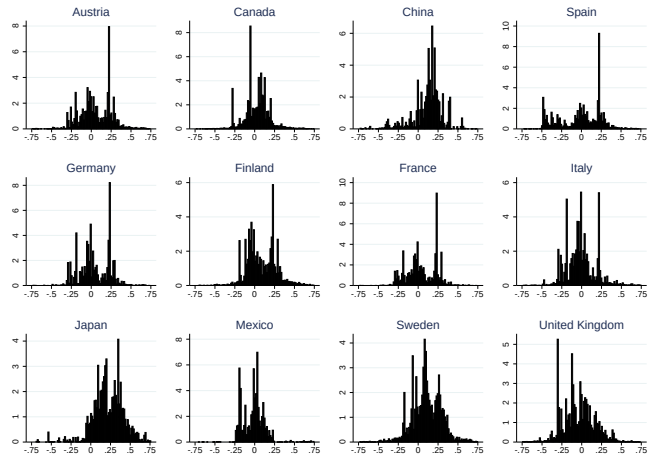
- To eliminate dependence on 3rd countries we take the average of the decomposition when $k = i$ and when $k = j$. Results are robust to obvious alternatives ▸ Alternative Decompositions
- From now on, we write these terms as:

$$q_{ij}(z,t) = q_{ij}^{I}(z,t) + q_{ij}^{D}(z,t) + q_{ij}^{S}(z,t)$$

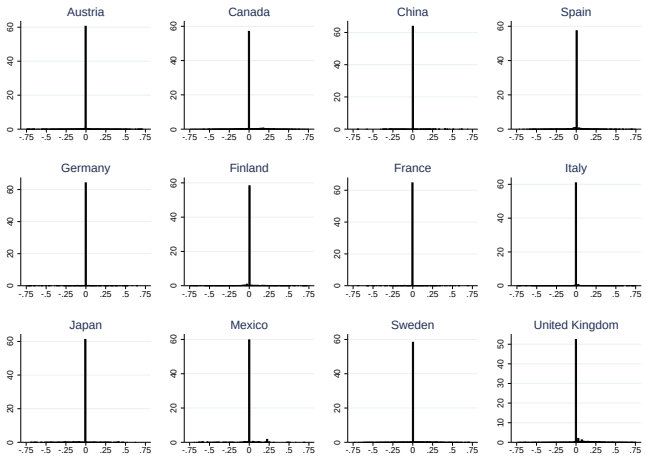
Decomposition $q_{ij} = q_{ij}^I + q_{ij}^D + q_{ij}^S$ for $j =$ United States



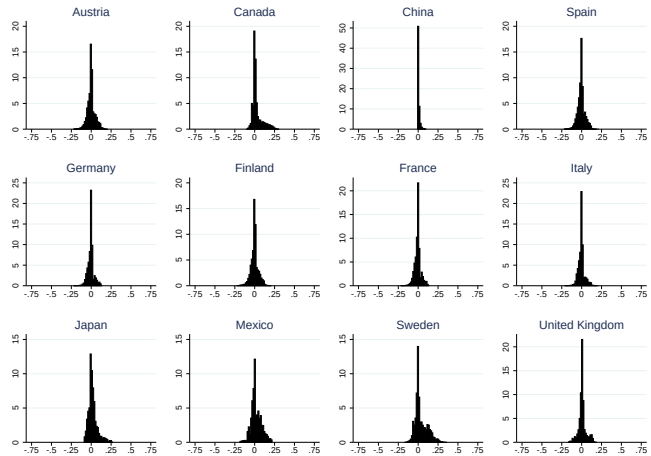
(a) Good-level RER (q_{ij})



(b) RER At Intro (q_{ij}^I)

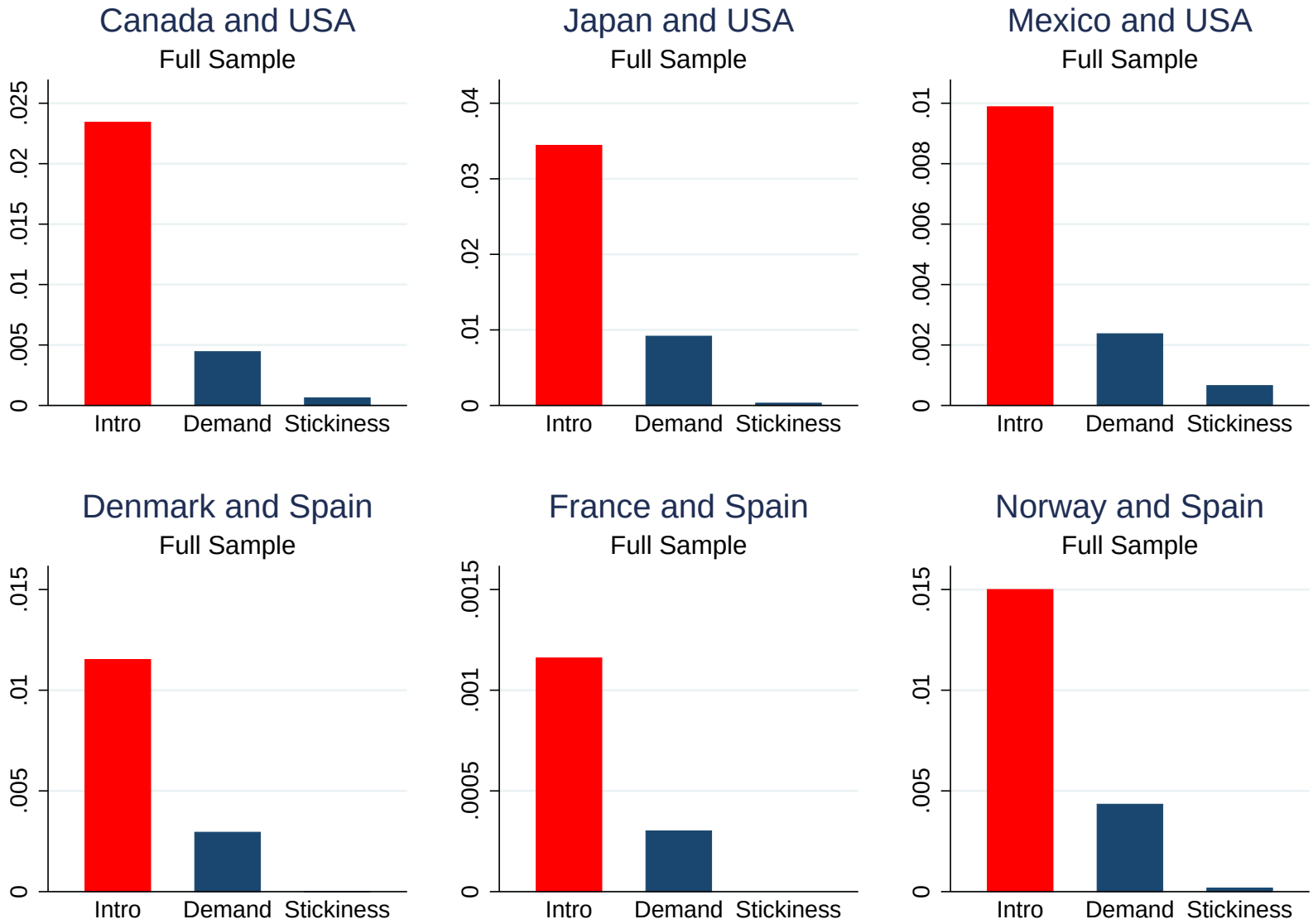


(c) Changes in Demand (q_{ij}^D)



(d) Stickiness (q_{ij}^S)

Decomposing Cross-Sectional Variation in q_{ij}

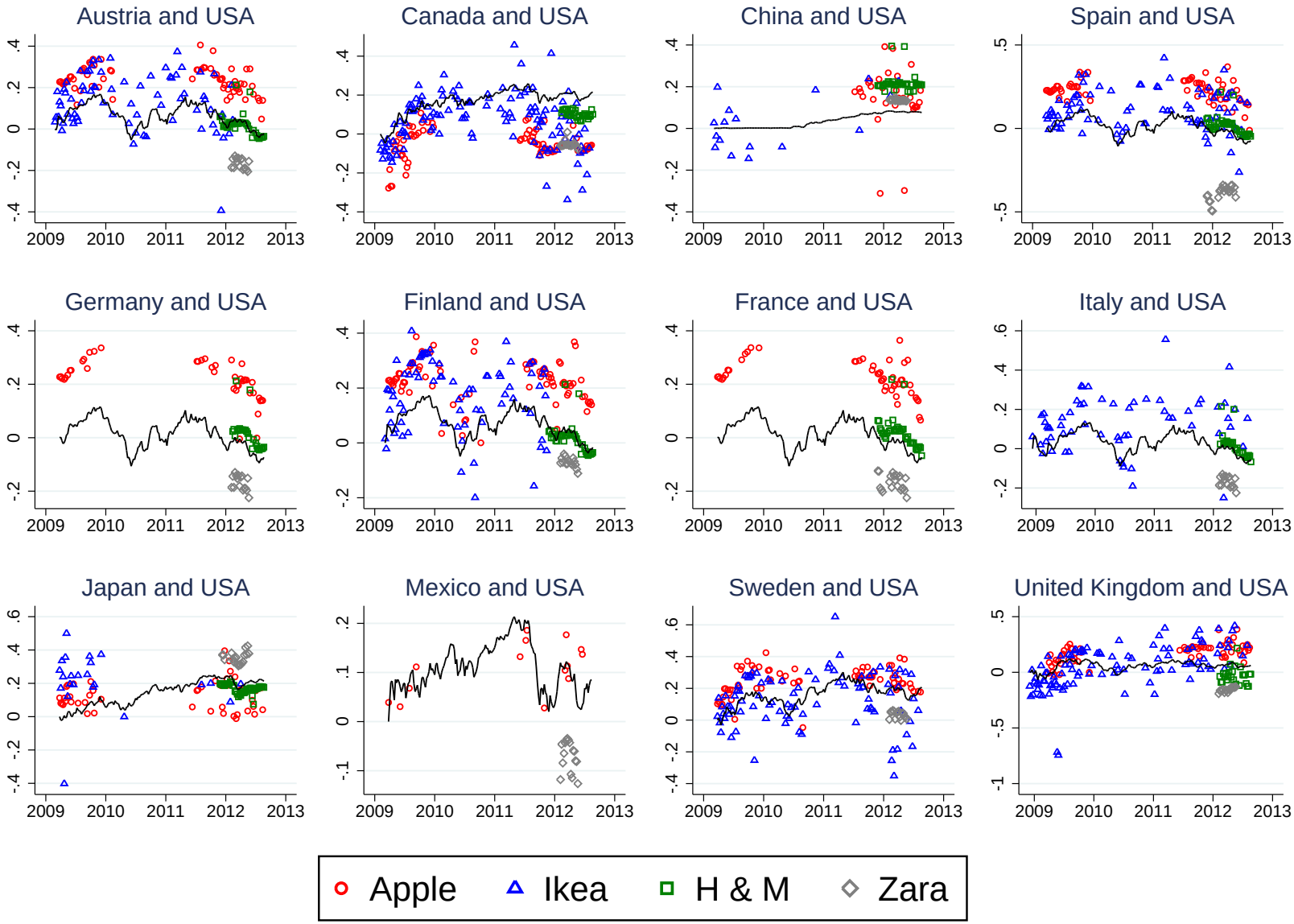


Importance of q_{ij}^{I} for RER measurement

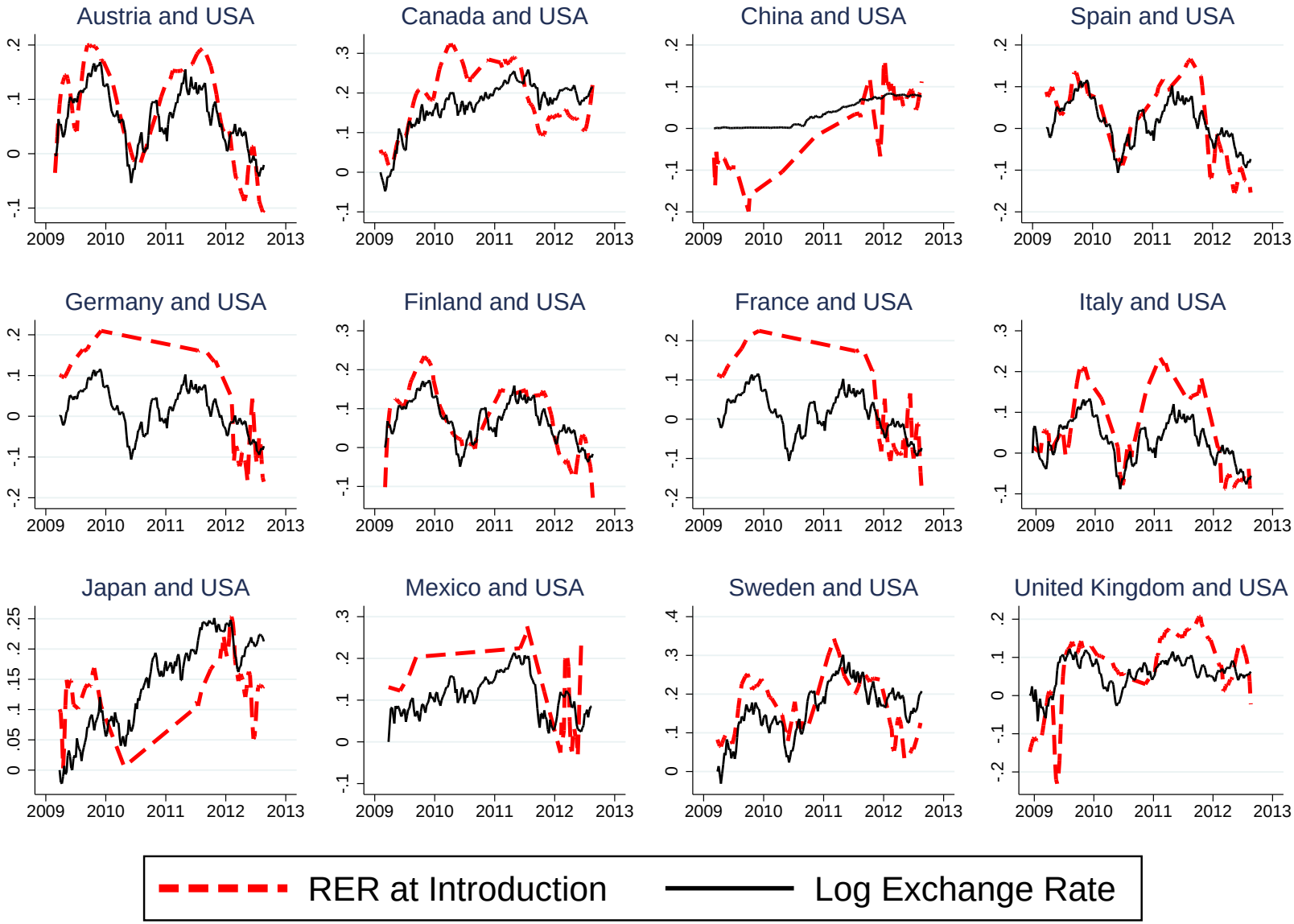
- Price indices use *changes*, not *levels*, so omit info in q_{ij}^{I}
  - For example, CPI-based RERs will not distinguish behavior for CU vs. Peg, because behavior is same after introduction

- Plausible Explanation for PPP Persistence Puzzle?
  - RER adjustment could happen via q_{ij}^{I} instead of via price changes ▸ details
  - However, the puzzle is not solved in our data: q_{ij}^{I} co-moves closely with the NER

Good-level RERs at Introduction vs. NER, Raw Data



Good-level RERs at Introduction vs. NER, Lowess



Good-level RERs at Introduction vs. NER, Regression

Dependent Variable: Good-Level Log RER at Introduction q_{ij}^{I}
Independent Variable: Log NER
Fixed Effects: Country Pair Effects

			All Stores	**Apple**	**IKEA**	**H&M**	**Zara**
(i)	All	Coef.	0.590	0.485	0.836	0.882	0.772
	Bilats.	S.E.	(0.008)	(0.012)	(0.029)	(0.006)	(0.011)
		Obs.	19,908,201	352,069	872,285	3,318,516	15,365,331
(ii)	All	Coef.	0.715	0.617	0.989	1.046	0.747
	U.S.	S.E.	(0.025)	(0.030)	(0.048)	(0.027)	(0.052)
	Bilats.	Obs.	602,325	25,447	57,576	142,284	377,018

Conclusions and Implications

- What determines market segmentation? Being in a currency union appears to be far more important than:
  - Distance
  - Culture
  - Taxes or tariffs
  - NER volatility
- Macro implications
  - Optimal currency areas
  - Cost of "internal devaluations"

Conclusions and Implications

- Modeling and measurement of RER
  - PCP vs. LCP modeling
  - RER at Intro closely tracking NER contrasts sharply with canonical models of good-level price stickiness. Suggests greater role for real rigidities.
  - Standard measures of RER omit critical information $\rightarrow$ we need more focus on q_{ij}^{I}

EXTRA SLIDES

Extra Slides

- Euro Competition regulations See
- Other Retailers See
- Price Points See
- Frequency and Life-Cycle See
- Measure Passthrough? See
- CU Regression Results See
- Connecting good-level RER to aggregate RER See
- Alternative Decompositions See

Summary Statistics

		All Stores	Apple	IKEA	H&M	Zara
(i)	# Prod., World	89,705	9,078	60,040	9,402	11,185
(ii)	# Prod., U.S.	33,602	4,349	17,597	4,107	7,549
(iii)	# Countries	81	29	20	47	78
(iv)	Time Period	2008:Q4 to 2012:Q3	2009:Q2 to 2012:Q3	2008:Q4 to 2012:Q3	2011:Q3 to 2012:Q3	2011:Q3 to 2012:Q2
(v)	Headquarters		United States	Sweden	Sweden	Spain
(vi)	Industry		Consumer Electronics	Home/Office Furniture	Apparel	Apparel
(vii)	Global Ind. Rank		3rd largest	1st largest	4th largest	3rd largest
(viii)	Retail Revs ($B)	$\approx$ 100	$\approx$ 40	$\approx$ 25	$\approx$ 15	$\approx$ 15

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"Live" Demonstration

- High-end (i.e. $>$ \$400) expresso maker sold by IKEA
  - Spain:
    `www.ikea.com/es/es/catalog/products/40113043/`
  - Portugal:
    `www.ikea.com/pt/pt/catalog/products/40113043/`
  - Italy:
    `www.ikea.com/it/it/catalog/products/40113043/`
  - Finland:
    `www.ikea.com/fi/fi/catalog/products/40113043/`
  - Denmark:
    `www.ikea.com/dk/da/catalog/products/40113043/`
- Danish price is more than 12% higher

Regression Results

Dependent Variable: Average Absolute Value of Good-Level Log RER						
		All Stores	**Apple**	**IKEA**	**H&M**	**Zara**
(i)	Outside of Cur. Unions	0.153 (0.006)	0.091 (0.010)	0.033 (0.005)	0.110 (0.006)	0.189 (0.009)
(ii)	Pegged NER	-0.040 (0.005)	-0.072 (0.025)	-0.004 (0.005)	-0.001 (0.006)	-0.054 (0.007)
(iii)	Log NER Volatility	-0.006 (0.012)	-0.004 (0.010)	-0.044 (0.007)	0.034 (0.034)	0.083 (0.041)
(iv)	Log Bilateral Distance	0.015 (0.002)	0.028 (0.004)	0.007 (0.002)	0.012 (0.003)	0.017 (0.003)
(v)	Abs. Relative Income	0.003 (0.002)	0.001 (0.005)	0.036 (0.009)	0.007 (0.006)	0.000 (0.002)
(vi)	Abs. Relative Taxes	-0.028 (0.025)	0.040 (0.040)	0.006 (0.031)	-0.023 (0.035)	-0.029 (0.030)
	Cty. Dumies:	Y	Y	Y	Y	Y

Competition Policy

Highly unlikely that competition is driving our results because:

1. We asked european lawyers and the European Competition Comission, and they confirmed there are no laws requiring identical prices in all euro countries.
2. All product market regulations apply at the EU level, not the euro zone level, so would also apply to Denmark and Sweden.
3. Bailey and Whish (2012): "In *United Brands v Commission* the Court of Justice ruled that 'it was permissible for a supplier to charge whatever local conditions of supply and demand dictate, that is to say that there is no obligation to charge a uniform price throughout the EU.'"
4. All countries had non-trivial number of price differences in the euro zone. Zara almost always charges different amounts in Spain/Portugal vs. rest of euro zone.
5. Inconsistent with results on dollarized countries vs. dollar pegs

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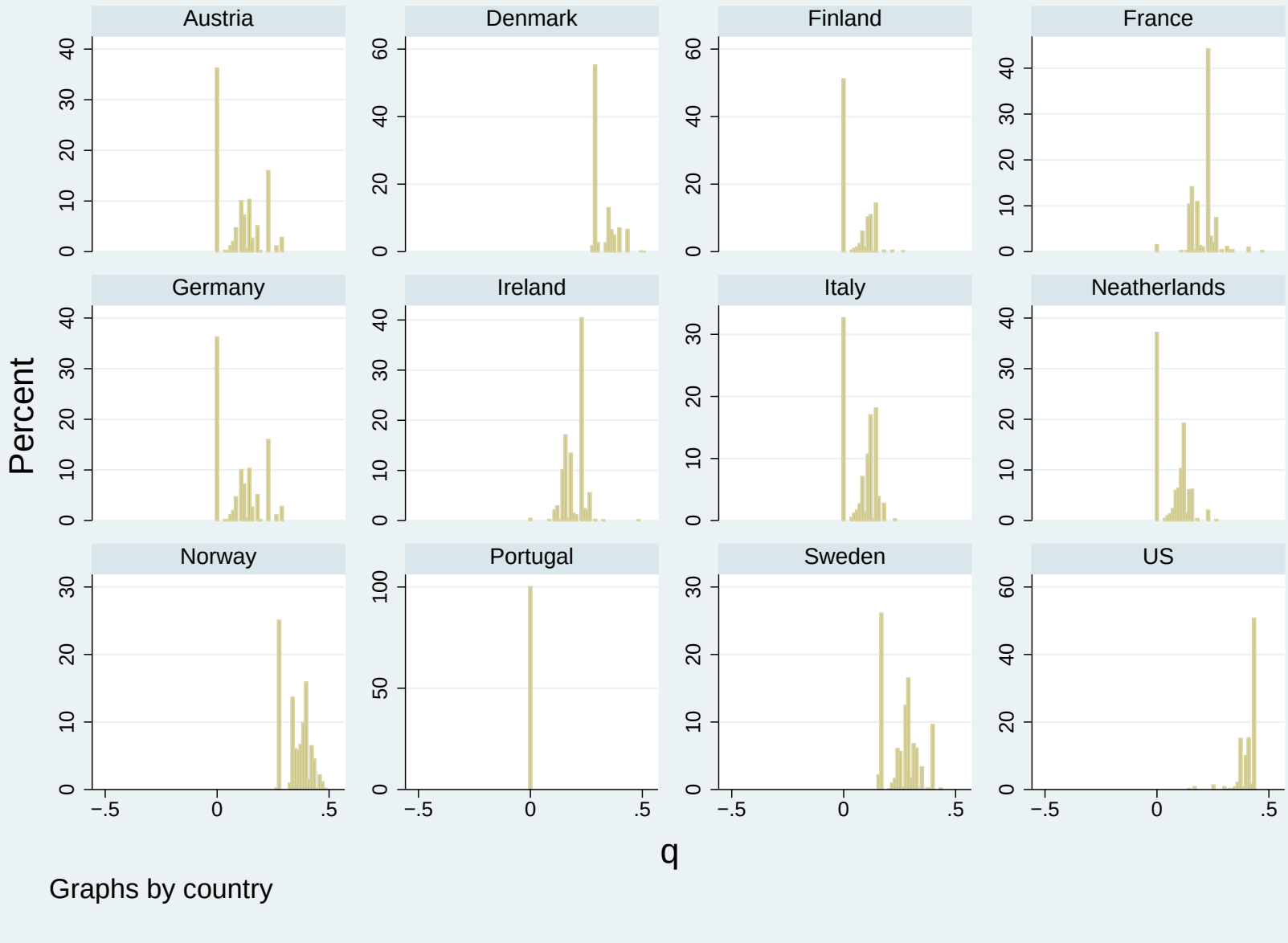
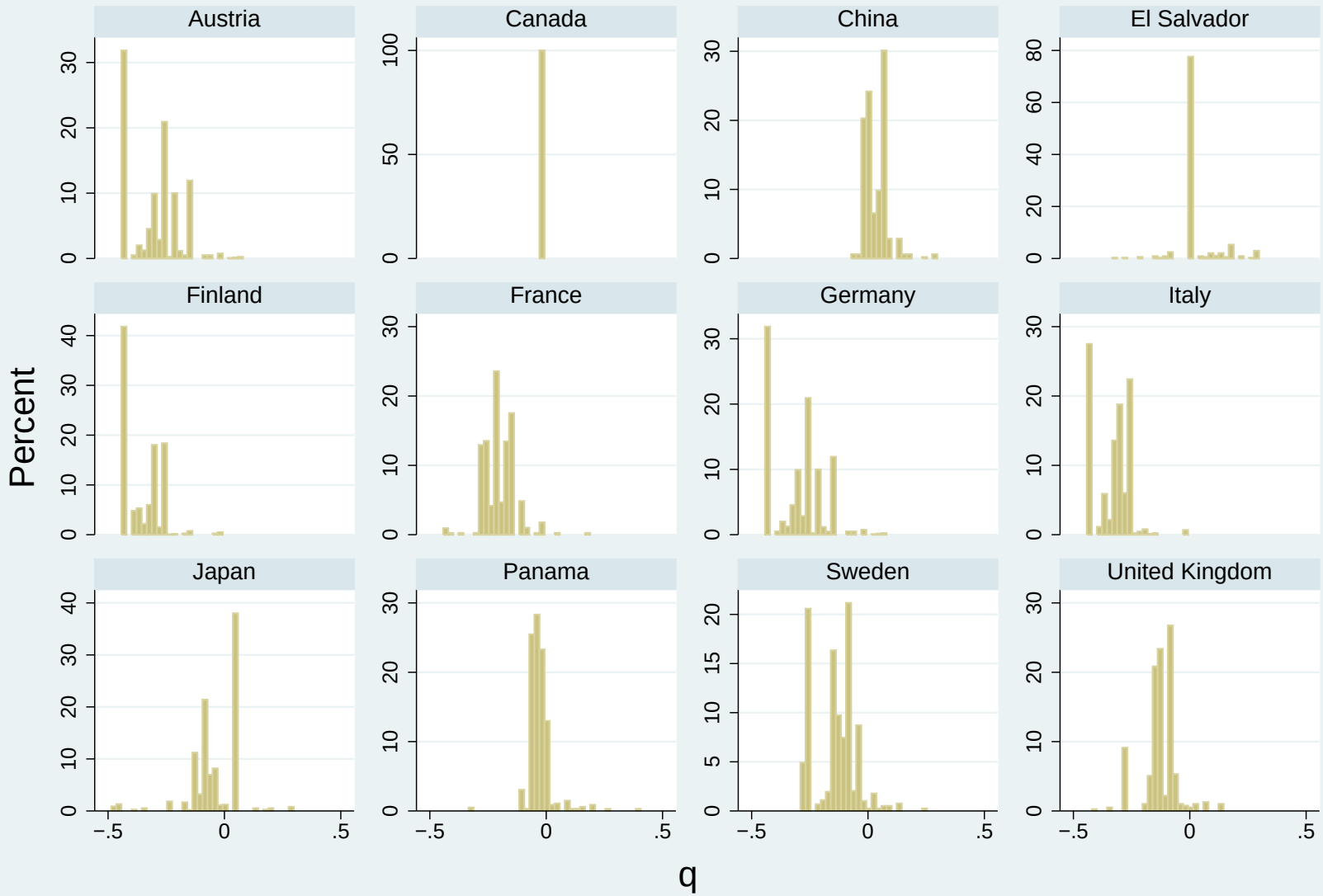
Retailer "Mango" , q_{ij} for j = Spain



Retailer "Mango" , q_{ij} for j = US



Other Retailers

Average Absolute Value of Good-Level Log RER

	Apple	**IKEA**	**H&M**	**Zara**	**Mango***
Currency Unions	0.005	0.117	0.021	0.087	0.11
NER Pegs	0.047	0.164	0.141	0.087	0.20
Floats	0.139	0.185	0.152	0.192	0.18

*Based on 5 days, 1300 goods, 52 countries

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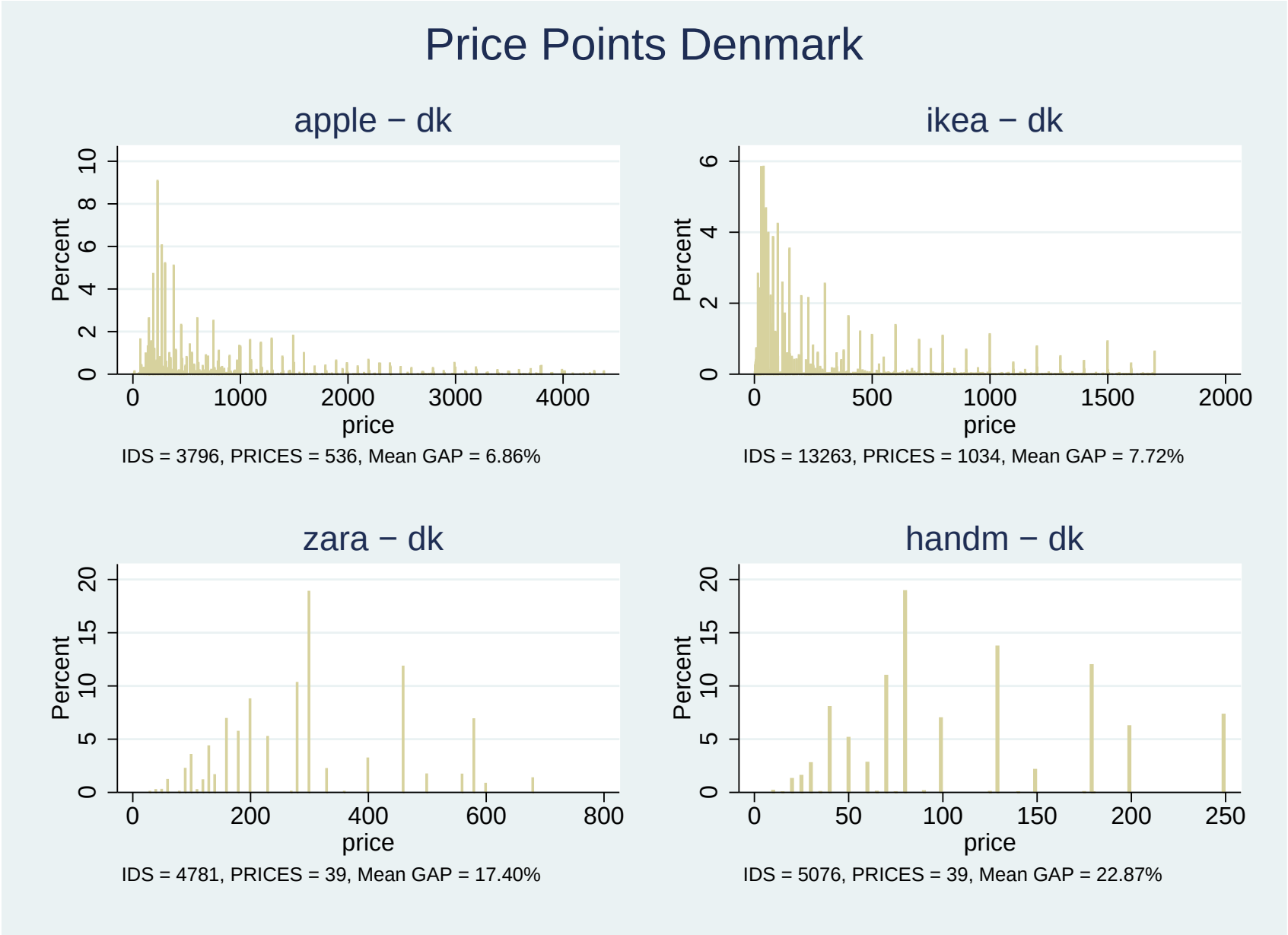
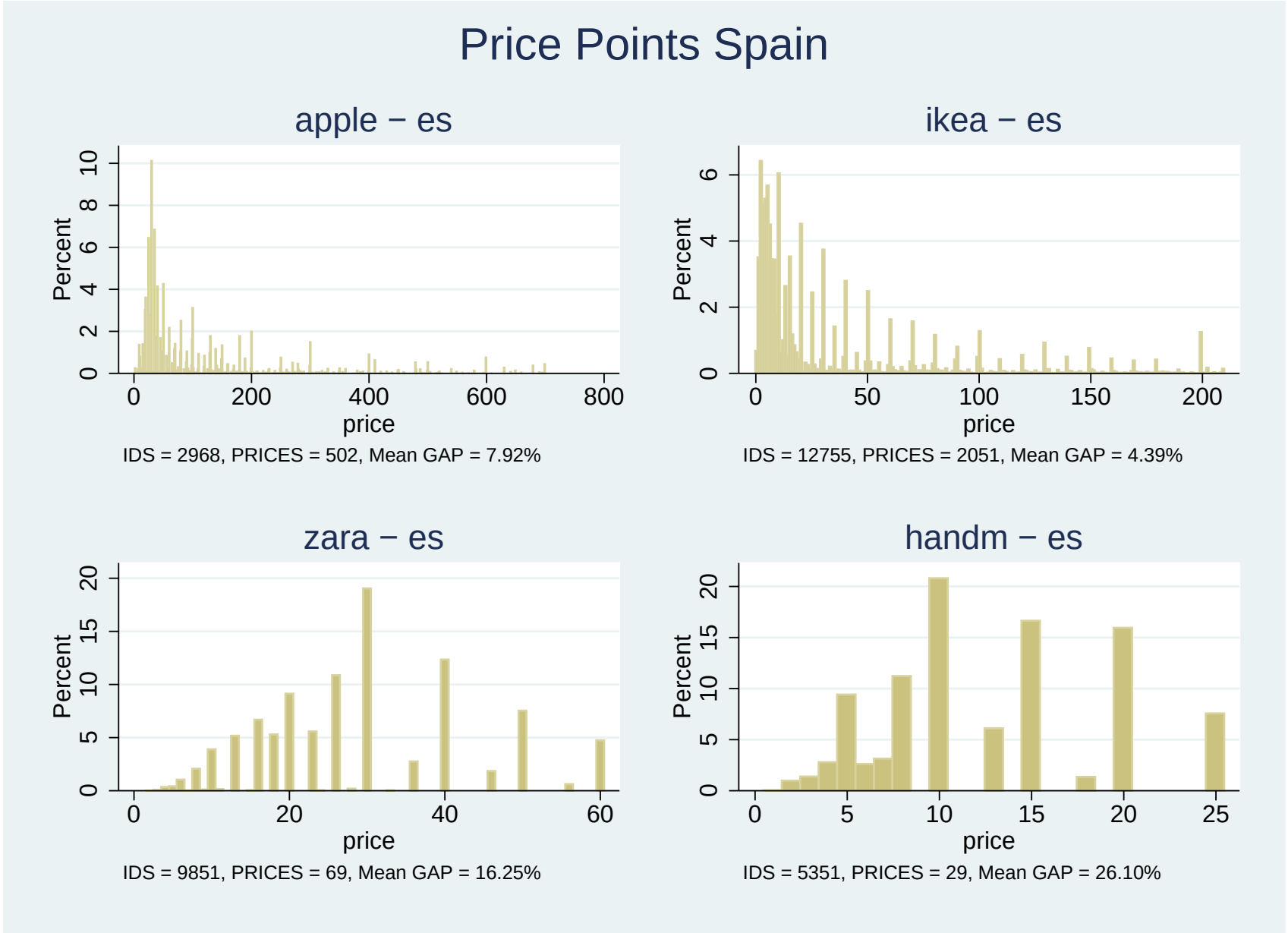
Price Points



Price Points



Unconditional Averages by Price Level

Average Absolute Value of Good-Level Log RER

		All Stores	Apple	IKEA	H&M	Zara
All Data	Currency Unions	0.062	0.005	0.117	0.021	0.087
All Data	NER Pegs	0.149	0.047	0.164	0.141	0.142
All Data	Floats	0.182	0.139	0.185	0.152	0.192
$(p_i + p_j) > \$100$	Currency Unions	0.058	0.007	0.094	0.004	0.075
$(p_i + p_j) > \$100$	NER Pegs	0.174	0.039	0.132	0.138	0.155
$(p_i + p_j) > \$100$	Floats	0.187	0.135	0.160	0.162	0.189
$(p_i + p_j) > \$400$	Currency Unions	0.041	0.010	0.084	0.021	0.116
$(p_i + p_j) > \$400$	NER Pegs*	0.308	0.038	0.123	0.135	0.387
$(p_i + p_j) > \$400$	Floats	0.169	0.138	0.148	0.161	0.231

*Based on a small number of observations.

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Benefits of Using Online Prices

- Large quantity of data
- Identical products, but not "too identical" (less restrictive than UPC)
- Sold by single retailer in multiple countries
- Can observe price at introduction
- Allows precise estimate of role of NER

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Environment (1/2)

- Many countries $i = 1..I$ with representative consumer (homothetic preferences)
- $\Omega_i(t)$ denotes goods available in i at t.
- Each good is manufactured in one plant and shipped internationally subject to good-country specific fixed cost, which generates differences in Ωs
- First-order approximation around SS expenditure weights to log of ideal price index (up to a constant):

$$\hat{p}_i(t) = \sum_{z \in \Omega_i(t)} \omega_i(z)\, p_i(z,t),$$

with $\omega_i(z)$ denoting good z's share of steady state spending

Environment (2/2)

- Assume z has same SS expenditure shares when consumed:

$$\begin{aligned}\hat{q}_{ij}(t) &= \omega_{ij} \sum_{z \in \Omega_{ij}(t)} q_{ij}(z,t) \\ &+ (1-\omega_{ij}) \sum_{z \in \Omega_{i-j}(t)} (p_i(z,t) - e_{ij}(t)) \\ &- (1-\omega_{ij}) \sum_{z \in \Omega_{j-i}(t)} p_j(z,t),\end{aligned}$$

  where ω_{ij} is total share of all $z \in \Omega_{ij}(t)$ consumed in i and j

- $\Omega_{ij}(t) = \Omega_i(t) \cap \Omega_j(t)$ and $\Omega_{i-j}(t) = \Omega_i(t) - \Omega_j(t)$

- Product innovations are unmodeled

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RER Decomposition - Timing Assymetries

- $q_{ij}(z,t)$ is independent of k, but decomposition isn't
- But, note that if $i_i(z) = i_j(z)$ and $l_i(z,t) = l_j(z,t)$, we have:

$$\begin{aligned} q_{ij}(z,t) &= \underbrace{\bar{p}_i(z) - e_{ij}(i_i(z)) - \bar{p}_j(z)}_{\text{Good-Level RER at Introduction}} \\ &+ \underbrace{\Delta_{i_i(z)}^{l_i(z,t)}(p_i(z) - p_j(z) - e_{ij})}_{\text{Heterogeneous Demand}} - \underbrace{\Delta_{l_i(z,t)}^{t} e_{ij}}_{\text{Stickiness}}, \end{aligned}$$

  which has no dependence on k

- So dependence on k is all about timing asymmetries

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RER Decomposition

- To eliminate dependence on 3rd countries, caused by timing asymmetries, we take the average of the decomposition when $k = i$ and when $k = j$:

$$
\begin{aligned}
q_{ij}(z,t) &= \underbrace{\bar{p}_i(z) - \bar{p}_j(z) - \frac{1}{2}e_{ij}(i_i(z)) - \frac{1}{2}e_{ij}(i_j(z))}_{\text{Introduction } q_{ij}^I} \\
&- \underbrace{\left[\frac{1}{2}\Delta^t_{I_i(z,t)}e_{ij} + \frac{1}{2}\Delta^t_{I_j(z,t)}e_{ij}\right]}_{\text{Stickiness } q_{ij}^S} \\
&+ \underbrace{\Delta^{I_i(z,t)}_{i_i(z)}p_i(z) - \Delta^{I_j(z,t)}_{i_j(z)}p_j(z) - \frac{1}{2}\Delta^{I_i(z,t)}_{i_i(z)}e_{ij} - \frac{1}{2}\Delta^{I_j(z,t)}_{i_j(z)}e_{ij}}_{\text{Demand } q_{ij}^D}.
\end{aligned}
$$

▸ Back - Slides ▸ Back - Extra Slides

First Alternative RER Decomposition

- The first alternative sets $q_{ij}^{I} = q_{ij}(z, i_{ij}^{*}(z))$, where $i_{ij}^{*}(z) = \max\{i_i(z), i_j(z)\}$
- We leave the definition of q_{ij}^{S} unchanged
- This results in:

$$
\begin{aligned}
q_{ij}(z,t) \quad = \quad & \underbrace{q_{ij}\left(z, i_{ij}^{*}(z)\right)}_{\text{Introduction } q_{ij}^{I}} - \underbrace{\left[\frac{1}{2}\Delta_{I_i(z,t)}^{t} e_{ij} + \frac{1}{2}\Delta_{I_j(z,t)}^{t} e_{ij}\right]}_{\text{Stickiness } q_{ij}^{S}} \\
& + \underbrace{\Delta_{i_{ij}^{*}(z)}^{I_i(z,t)} p_i(z) - \Delta_{i_{ij}^{*}(z)}^{I_j(z,t)} p_j(z) - \frac{1}{2}\Delta_{i_{ij}^{*}(z)}^{I_i(z,t)} e_{ij} - \frac{1}{2}\Delta_{i_{ij}^{*}(z)}^{I_j(z,t)} e_{ij}}_{\text{Demand } q_{ij}^{D}}
\end{aligned}
$$

- $q_{ij}^{D} \neq 0$, even if there are no price changes

Second Alternative RER Decomposition

- The second alternative sets $q_{ij}^S = -\Delta^t_{t_{ij}^*(z,t)} e_{ij}$, where $t_{ij}^*(z,t) = \max\{l_i(z,t), l_j(z,t)\}$
- We leave the definition of q_{ij}^I unchanged
- This results in:

$$q_{ij}(z,t) = \underbrace{\left[\bar{p}_i(z) - \bar{p}_j(z) - \frac{1}{2}e_{ij}(i_i(z)) - \frac{1}{2}e_{ij}(i_j(z))\right]}_{\text{Introduction } q_{ij}^I} - \underbrace{\Delta^t_{t_{ij}^*(z,t)} e_{ij}}_{\text{Stickiness } q_{ij}^S}$$
$$+ \underbrace{\left[\Delta^{l_i(z,t)}_{i_i(z)} p_i(z) - \Delta^{l_j(z,t)}_{i_j(z)} p_j(z) - \frac{1}{2}\Delta^{t_{ij}^*(z,t)}_{i_i(z)} e_{ij} - \frac{1}{2}\Delta^{t_{ij}^*(z,t)}_{i_j(z)} e_{ij}\right]}_{\text{Demand } q_{ij}^D}$$

- $q_{ij}^D \neq 0$, even if there are no price changes

Third Alternative RER Decomposition

- The third alternative combines both changes
- This results in:

$$q_{ij}(z,t) = \underbrace{q_{ij}\left(z, i^*_{ij}(z)\right)}_{\text{Introduction } q^I_{ij}} + \underbrace{\Delta^{t^*_{ij}(z,t)}_{i^*_{ij}(z)} q_{ij}(z)}_{\text{Demand } q^D_{ij}} - \underbrace{\Delta^{t}_{t^*_{ij}(z,t)} e_{ij}}_{\text{Stickiness } q^S_{ij}}$$

- $q^D_{ij} = 0$ only if there are no price changes
- Pros/cons of each. Paper details why we prefer baseline.
- Appendix shows all results are highly robust to any of these.

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Cross-Sectional Variance Decomposition

- To formalize and quantify this, we write:

$$\sigma_{ij}^2(t) = \underbrace{\left(\tilde{\sigma}_{ij}^I\right)^2(t)}_{\text{RER at Intro}} + \underbrace{\left(\tilde{\sigma}_{ij}^D\right)^2(t)}_{\text{Demand}} + \underbrace{\left(\tilde{\sigma}_{ij}^S\right)^2(t)}_{\text{Stickiness}},$$

  where $\sigma_{ij}^2(t) = Var_z(q_{ij})$.

- We've split the (small) covariance terms equally:

$$\left(\tilde{\sigma}_{ij}^I\right)^2(t) = \left(\sigma_{ij}^I\right)^2(t) + \sigma_{ij}^{I,D}(t) + \sigma_{ij}^{I,S}(t),$$

  where $\left(\sigma_{ij}^I\right)^2 = Var_z(q_{ij}^I)$ and $\sigma_{ij}^{I,D} = Cov_z(q_{ij}^I, q_{ij}^D)$.

- We then average over weeks t

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Decomposition, Stickiness, and Entry/Exit

- If prices don't change, $q_{ij}^D = 0$ by construction. Share of all products (those with ≥ 52 weeks) with any changes:
  - Apple: 18% (39%)
  - IKEA: 30% (51%)
  - H&M: 3% (-)
  - Zara: 9% (-)

- If products constantly enter and exit, $\sigma_{ij}^2 = \left(\tilde{\sigma}_{ij}^I\right)^2$ by construction. Mean duration for U.S. pairs:
  - Apple: 31 weeks
  - IKEA: 55 weeks
  - H&M: 8 weeks
  - Zara: 9 weeks

- We consider "Reduced Sample" of goods with both ≥ 1 price change and ≥ 52 weeks. Takeaway still holds qualitatively.

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Relationship Between RERs at Intro and NER

- For IKEA and H&M, RER at Intro moves 1:1 with NER
- For Apple and Zara, RER at Intro moves 0.7:1 with NER
- Cannot therefore explain PPP Puzzle with this
- Rejects adjustment cost models where RER shocks disappear with price changes. After all, introduction price **is** new price.
- How compares to ER passthrough? Can't tell exactly, but seems like even less adjustment

Plausible Explanation of PPP Puzzle?

- Suppose prices never change (so RER of existing goods tracks NER), but goods frequently enter/exit
  - If q_{ij}^l drawn i.i.d. from distribution with mean $\tilde{q}$, average RER cannot wander too far from $\tilde{q}$ (product life cycle would be critical for RER half-life)
  - But since price indices ignore intros, our measures of RER could still wander arbitrarily from $\tilde{q}$
- However, the puzzle is not solved in our data: q_{ij}^l moves closely with NER. ▸ Back

Measuring Passthrough Is Hard Without Knowing Exporter

- We don't know identity of exporting country
- Imagine unobserved exporter is Japan. PT to Spain is 0.75 and to US is 0.25.
- Prices change only due to exchange rate
- 10% depreciation of euro-yen with no change in dollar-yen produces 7.5% appreciation of Spain-US relative price
- 10% appreciation of the dollar-yen with no change in euro-yen produces 2.5% appreciation
- But both scenarios produce same movement in dollar-euro
- In other work, trying to use panel to make progress on this

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