

Pricing-to-Market: Evidence From Plant-Level Prices

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Question

- ▶ How do desired relative markups across markets co-move with exchange rates, for producers whose prices are sticky in destination currency?

Our empirical strategy

Exploit structure of a unique data set:

- ▶ Matched price quotes for same product produced and sold by same plant in two markets segmented by exchange rates (Ireland: IEP/Euro and UK: Sterling)
 - ▶ Cleanly identify relative markup responses to exchange rate movements by controlling for marginal cost using fixed effects
- ▶ Monthly data; prices are sticky; observe timing of changes
 - ▶ Separate out *desired* from *passive* relative markup variation by focusing on episodes where prices change

Bottom line

- ▶ For prices invoiced in **destination currency**, desired relative markups move **one-for-one** with exchange rate changes in the interval from one price change to the next

Data

Irish Census of Industrial Production (CIP)

- ▶ All plants in manufacturing and mining (5000 plants)
- ▶ Annual data, 1995-2005
- ▶ Detailed data on exports, imported intermediates and invoicing, especially for UK

Micro data for Irish Producer Price Index (PPI)

- ▶ Subsample of CIP (550-900 plants)
- ▶ Monthly data, Jan 1995-Nov 2006
- ▶ Prices for plants' main products
 - ▶ e.g. Chocolate biscuits, hypodermic syringes
- ▶ Matched home and export prices
- ▶ For exports know invoice currency, but not precise destination
- ▶ Assume Sterling-invoiced exports sold to UK

Matched price quotes

PRODUCT CATEGORY	SPECIFIC ITEMS SELECTED FOR PRICING								
(1) General description and tariff codes for unfamiliar items. Please specify estimated Home/Export percentages for the product category.	(2) Detailed specification of selected items (description, model number etc.) Select up to 4 representative items in each section.	(3) % Sales Value	(4) Trading terms - most usual (type of customer, order size, delivery terms, discount procedure, currency surcharges, etc.)	% Discount on basic price	(5) Supply (please 'v')		(5) Country of Sale	(6) Basic price before discounts or surcharges on 15th of month	
					Ex Stock	To Order		(for exports State main Market)	Price (exclude VAT)
Example Bread Specify:- Home Sales 90 % Export Sales 10 % Total 100%	Home Sales (1) ...Bread (unsliced) 800 Grams (2) ...Bread (sliced) 800 Grams (3) ...Soda Bread 400 GramsTotal	20% 60% 20% 100%	Retail Outlets 30 days credit	% -2.50	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/> <input checked="" type="checkbox"/>	} Ireland	(specify currency) €5.00 €7.00 €50.00	10's 10's 100's
	Export Sales (1) ...Soda Bread 400 Grams (2) (3) (4)Total	100% 100%	Retail Outlets 30 days credit	% -3.00	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	U.K.	(specify currency) £50.00 stg	100's
Specify: Home Sales % Export Sales % Total 100%	Home Sales (1) (2) (3) (4)Total 100%	%	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	} Ireland	(specify currency)
	Export Sales (1) (2) (3) (4)Total 100%	%	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	(specify currency)
	Home Sales			%				(specify currency)	

Prices are sticky in invoice currency

Weighted mean frequency of invoice currency price changes

	Frequency
All obs.	0.16
By destination market	
Home	0.19
Export	0.14
By invoice currency for exports	
IEP,EUR	0.11
STG	0.16

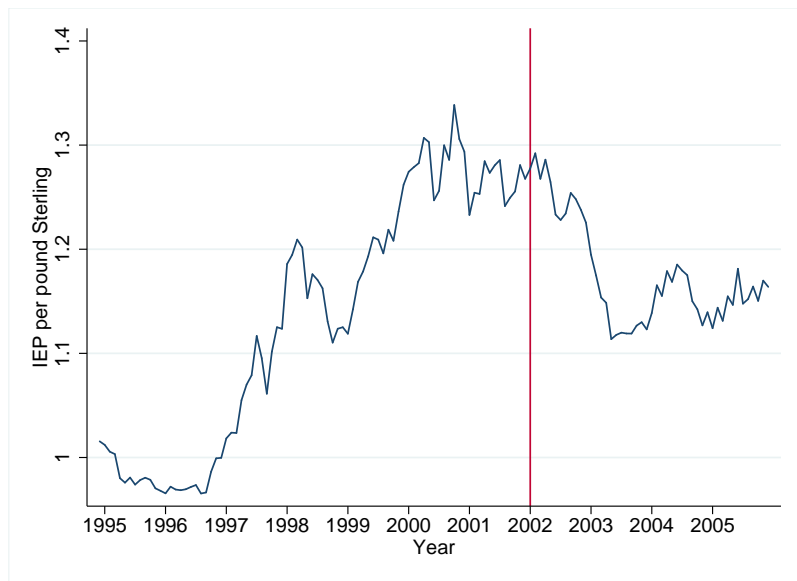
Note: Weighted by sales at level of plant-market-year

Price-adjustment is synchronized

Percent plant-prod-mths with > 1 quotes and ≥ 1 price changes where

	One price changes	> 1 , $<$ all change	All change
Full sample	21	28	51
IRL,UK sample	28	45	28

Flexible exchange rate between Irl & UK



Organizing framework

- ▶ Latent *desired home currency price* for plant-product pair i in market k at t :

$$\hat{p}_t^{ik} = \gamma^{ik} mc_t^i \hat{\mu}_t^{ik}$$

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$$\Delta_{s_t^{ik}} \ln \hat{p}_t^{ik} = \alpha + \theta_{t, s_t^{ik}}^i + \beta \Delta_{s_t^{ik}} \ln e_t^k + \varepsilon_{t, s_t^{ik}}^{ik}$$

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- ▶ $\theta_{t,s_t^{ik}}^i$ is a fixed effect that picks up $\Delta_{s_t^{ik}} \ln mc_t^i$
- ▶ Want to estimate β

Interpretation of β

- ▶ β is a function of market structure, price stickiness, and the process for demand and cost shocks
- ▶ If $\beta = 0$, have constant desired relative markups
- ▶ If $\beta \neq 0$, have “pricing-to-market” conditional on price changes

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- ▶ If $\beta = 0$, have constant desired relative markups
- ▶ If $\beta \neq 0$, have “pricing-to-market” conditional on price changes
- ▶ With destination currency invoicing and sticky prices, by default relative markups move one-for-one with exchange rates
- ▶ With home currency invoicing and sticky prices, by default relative markups do not co-move with exchange rates

Empirical strategy

- ▶ Restrict attention to plant-product pairs with home price quotes in home currency and export quotes in Sterling
- ▶ *Observed* equals *desired* price change ($\Delta_{s_t^{ik}} \ln p_t^{ik} = \Delta_{s_t^{ik}} \ln \hat{p}_t^{ik}$) if destination currency price is changed at date t
- ▶ \Rightarrow Focus on episodes where at least some prices change
- ▶ Focus on cases where $s_t^{i,IRL} = s_t^{i,UK}$ (last price change synchronized across markets) so β is identified

Empirical strategy: extensive margin

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$$\Delta_{s_t^{ik}} \ln \hat{p}_t^{ik*} = \alpha + \theta_{t,s_t^{ik}}^i + (\beta - 1) \Delta_{s_t^{ik}} \ln e_t^k + \varepsilon_{t,s_t^{ik}}^{ik}$$

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- ▶ Estimate conditional logit for increases

$$\Pr \left[\Delta_{s_t^{ik}} \ln p_t^{ik*} > 0 \right] = \Lambda \left(\psi_{t,s_t^{ik}}^i + (\beta - 1) \Delta_{s_t^{ik}} \ln e_t^k \right)$$

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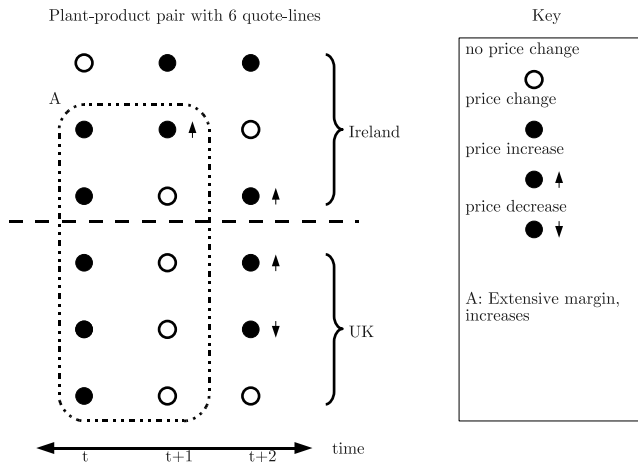
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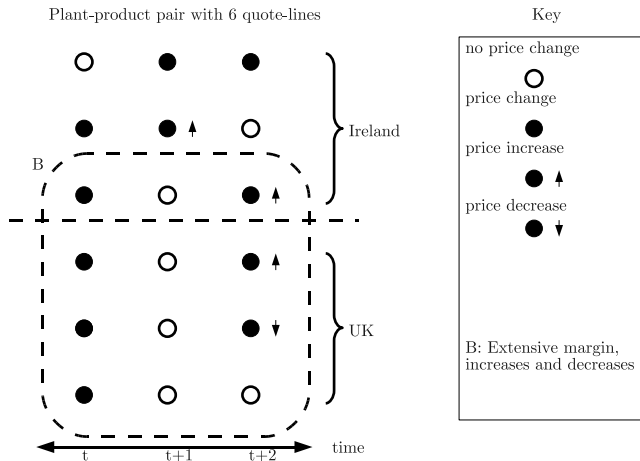
- ▶ Similarly for decreases

$$\Pr \left[\Delta_{s_t^{ik}} \ln p_t^{ik*} < 0 \right] = \Lambda \left(\phi_{t, s_t^{ik}}^i - (\beta - 1) \Delta_{s_t^{ik}} \ln e_t^k \right)$$

Episodes used to identify extensive margin I



Episodes used to identify extensive margin II

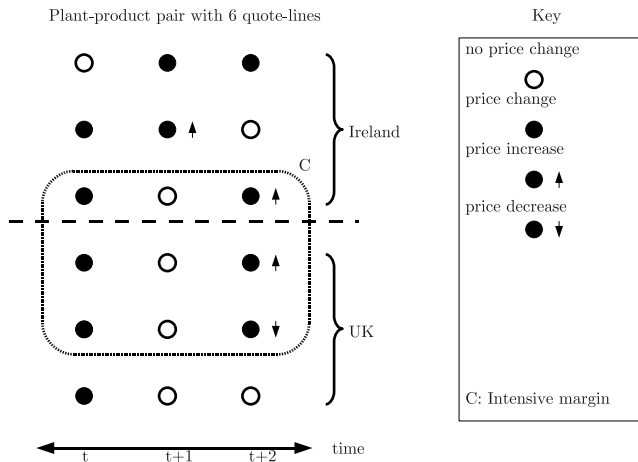


Empirical strategy: intensive margin

- ▶ If price changes in both markets simultaneously, relative markup depends on size of price changes
- ▶ Condition on destination currency prices changing in both markets at t , so $\Delta_{s_t^{ik}} \ln \hat{p}_t^{ik} = \Delta_{s_t^{ik}} \ln p_t^{ik}$
- ▶ Can then directly estimate

$$\Delta_{s_t^{ik}} \ln p_t^{ik} = \alpha + \theta_{t,s_t^{ik}}^i + \beta \Delta_{s_t^{ik}} \ln e_t^k + \varepsilon_{t,s_t^{ik}}^{ik}$$

Episodes used to identify intensive margin



Extensive margin results

$$\Pr[\text{increase}] = \Lambda \left(\psi_{t,s_t}^i + (\beta - 1) \Delta_{s_t}^{ik} \ln e_t^k \right)$$

$$\Pr[\text{decrease}] = \Lambda \left(\phi_{t,s_t}^i - (\beta - 1) \Delta_{s_t}^{ik} \ln e_t^k \right)$$

	Increases		Decreases	
	coeff.	s.e.	coeff.	s.e.
$\Delta_{s_t}^{ik} \ln e_t^k$	0.59	(3.61)	1.62	(4.99)
N	4873		4564	
# f.e.	921		875	
# clusters	129		103	
Pseudo-R ²	0.00		0.00	

Note: Estimation is by conditional logit. Dep var: indicator for increase or decrease in invoice currency price. Full set of plant-prod-mth-age f.e. Obs weighted by sales shares. S.E. clustered at plant level. ** signif at 5%, * signif at 10%

Intensive margin results

$$\Delta_{s_t^{ik}} \ln p_t^{ik} = \alpha + \theta_{t,s_t^{ik}}^i + \beta \Delta_{s_t^{ik}} \ln e_t^k + \varepsilon_{t,s_t^{ik}}^{ik}$$

	coeff.	s.e.
$\Delta_{s_t^{ik}} \ln e_t^k$	1.014	(0.086)**
N	4212	
# f.e.	1047	
# clusters	86	
R ² -adj	0.67	

Dep var: log change in home curr price since last price change. Full set of plant-prod-mth-age f.e. Obs weighted by sales shares. S.E. clustered at plant level. ** signif at 5%, * signif at 10%

Conclusions and further work

- ▶ Producers invoicing in destination currency desire one-for-one movement of relative markups with respect to exchange rate changes in the intervals between price changes

Conclusions and further work

- ▶ Producers invoicing in destination currency desire one-for-one movement of relative markups with respect to exchange rate changes in the intervals between price changes
- ▶ What combinations of market structure and price-setting behavior can match the moment we document?
- ▶ Alternatively, how big are losses in profits from this behavior under standard models?
- ▶ What are the implications for expenditure-switching effects of exchange rate movements?

Summary statistics

Hierarchical structure of the matched data

	Plants	Plant-prd. pairs	Quote- lines	Obs.
1995	670	1,103	4,890	54,045
1996	647	1,068	4,795	52,163
1997	627	1,040	4,658	51,022
1998	595	1,010	4,807	49,198
1999	555	947	4,174	46,327
2000	580	977	4,496	46,910
2001	653	1,074	4,929	50,017
2002	808	1,235	5,456	53,224
2003	877	1,327	5,820	59,752
2004	853	1,296	5,369	58,670
2005	836	1,243	4,995	56,428
total	1,214	1,947	12,235	577,756

Plant summary statistics

Export orientation

	1995	2005
<hr/>		
% of plants that export		
UK	48	39
Anywhere	53	46
<hr/>		
% of total in-sample sales exported		
UK	16	11
Anywhere	61	72
<hr/>		

Plant summary statistics

Invoice currency choice for exports to UK

	1995	2005
<hr/>		
% of total in-sample exports to UK		
GBP	77	69
IEP/EUR	9	20
Other	13	11
<hr/>		
% of plants exporting to UK		
GBP only	56	33
IEP/EUR only	22	18
Other	4	1
Mix	18	48
<hr/>		

Plant summary statistics

Exposure to imports

	1995	2005
<hr/>		
% of plants importing materials		
from UK	49	48
from anywhere	58	54
<hr/>		
% of total in-sample materials imported		
from UK	15	16
from anywhere	48	59
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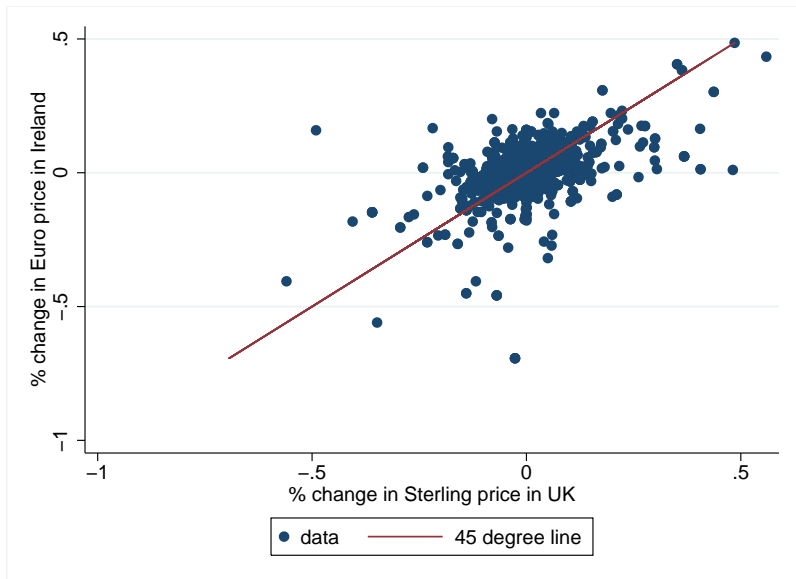
Plant summary statistics

Revenue net of variable cost as a share of revenue

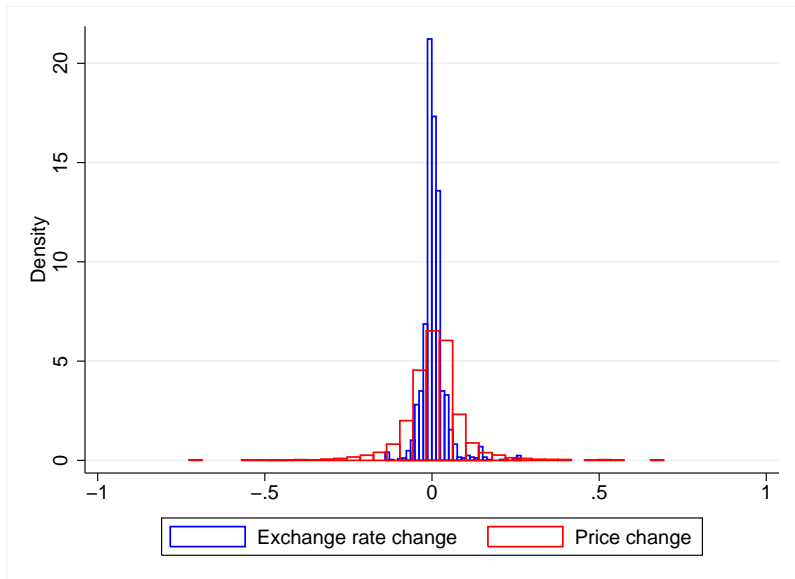
	1995	2005
p25	0.20	0.23
p50	0.31	0.35
p75	0.42	0.47

Note: Variable cost measured as wage bill plus intermediates and energy expenditures.

Data underlying the intensive margin estimates



Data underlying the intensive margin estimates



Pricing-to-market and invoice currency choice

Invoice currency and the extensive margin

		$\Delta_{s_t^{ik}} \ln e_t^k$	ps-R ²	N	f.e.	clust
Destination currency invoicing						
Pr(inc)	$\beta^{dest} - 1$	10.97 (7.92)	0.00	586	134	30
Pr(dec)	$1 - \beta^{dest}$	-6.76 (11.57)	0.00	552	131	25
Home currency invoicing						
Pr(inc)	β^{home}	22.96 (20.17)	0.02	640	151	42
Pr(dec)	$-\beta^{home}$	-13.01 (14.57)	0.00	503	129	29

Pricing-to-market and invoice currency choice

Invoice currency and the intensive margin

	$\Delta_{s_t^{ik}} \ln e_t^k$	R ² -adj	N	f.e.	clust.	
Destination currency invoicing						
β^{dest}	2.52 (1.22)*	0.68	741	235	40	
Home currency invoicing						
β^{home}	0.97 (0.57)*	0.66	745	236	41	

Intensive margin, first and last synchronized price changes

	$\Delta_{s_t^{ik}} \ln e_t^k$	R ² -adj.	N	f.e.	clust
First and last synchronized price changes, all observations					
	0.78 (0.51)	0.39	677	116	96
By interval between first and last price change					
<6 months	1.59 (5.03)	0.16	43	23	20
6-11 months	1.38 (0.88)	0.44	65	27	22
12-23 months	1.81 (1.34)	0.47	141	40	35
24+ months	0.74 (0.61)	0.36	428	75	66
By number of intervening price changes					
<2	0.86 (0.46)*	0.33	400	58	49
≥ 2	0.76 (0.66)	0.30	277	58	50