Lecture 5: Pricing to market and exchange rate pass through: empirics and theory

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Pricing-to-Market and Exchange Rate Pass-through
Betts & Devereux (1996)

Motivation

- Try to explain the low impact of exchange rate movements on prices of traded goods (incomplete ERPT)
- In traditional models: $P_t^M = E_t * P_t^X$ Any change in E_t is fully reflected into import prices (expressed in the importer's currency) $\longrightarrow$ Change the relative price of imported goods $\longrightarrow$ Expenditure switching effect (justifies flexible exchange rate regimes)
- In the data, import prices are unsensitive to exchange-rate shocks, at least in the short term
- Important consequences concerning the impact of exchange rate fuctuations and the optimality of flexible exchange rate regimes

$\Rightarrow$ Understanding the sources of incomplete pass-through has been a major concern in international macroeconomics over the last 10 years.

Intuition

- Betts & Devereux allow for PTM in a general equilibrium framework with sticky prices
- Pricing-to-Market: see Krugman (1987) and Dornbusch (1987). Exchange-rate fluctuations affecting the local price of exported goods may induce exporters to set different (FOB) prices in different export markets in order to smooth the impact of ER fluctuations
- In the paper, PTM is introduced by assuming that some firms set their price in their own currency (PCP) while some firms prefer fixing their export price directly in the importer's currency (LCP)
- When ERs fluctuate and prices are sticky, PCP implies full pass-through (as $P_t^M = E_t * \bar{P}_t^X$) while LCP implies no pass-through (as $\bar{P}_t^M = E_t * P_t^X$). Under LCP, the ER risk is transferred on the firm's mark-up while under PCP, it transmits into a risk of demand.
- In general equilibrium, incomplete ERPT implies that exchange rates must adjust more strongly following an asymmetric shock $\rightarrow$ Explains the high volatility of RERs with respect to the volatility of NERs.

Hypotheses

- Two country economy
- International markets are segmented $\rightarrow$ Consumers cannot without significant cost directly arbitrage between price differences across countries
- Prices are sticky $\rightarrow$ Don't adjust instantaneously to money shocks
- Product are differentiated:

$$C = \left[\int_0^1 c(i)^{\frac{\sigma-1}{\sigma}} di \right]^{\frac{\sigma}{\sigma-1}}$$

- Households supply labour, consume and value real money:

$$U = \left(logC + \frac{\gamma}{1-\epsilon} \left(\frac{M}{P} \right)^{1-\epsilon} + \eta log(1-h) \right)$$

- A share n of products are produced in the domestic country
- A share s of exporting firms sets their price under LCP
- Linear technology function: $y(i) = Ah(i)$

Households' behaviour

- Households solve the following 2-step program:

$$\begin{cases} \max_{C,h,M} \left(logC + \frac{\gamma}{1-\epsilon} \left(\frac{M}{P} \right)^{1-\epsilon} + \eta log(1-h) \right) \\ s.t.\ PC + M = Wh + \pi + M_0 + TR \end{cases}$$

$$\begin{cases} \max_{C(i)} \left[\int_0^1 c(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}} \\ s.t.\ PC = \int_0^1 v(i)c(i)di \end{cases}$$

where $v(i)$ is the price of variety i, either $p(i)$ if $i \in [0; n]$ or $p^*(i)$ if $i \in [n; n + (1-n)s]$ or $eq(i)^*$ if $i \in [n + (1-n)s; 1]$.

Households' behaviour (2)

- Optimality conditions:

$$\frac{1}{C} = \gamma \left(\frac{M}{P}\right)^{-\epsilon}$$
$$\frac{\eta}{1-h} = \frac{W}{PC}$$
$$c(i) = \left(\frac{v(i)}{P}\right)^{-\sigma}$$

- Ideal price index:

$$P = \left[\int_0^n p(i)^{1-\sigma} di + \int_n^{n+(1-n)s} p^*(i)^{1-\sigma} + \int_{n+(1-n)s}^1 (eq^*(i))^{1-\sigma} di\right]^{\frac{1}{1-\sigma}}$$

- The situation of foreign households is entirely analogous.

Firms' behaviour

- LCP firms solve the following program:

$$\begin{cases} \max_{p(i),q(i)} \pi^{LCP}(i) = p(i)c(i) + eq(i)c^*(i) - \frac{W}{A}(c(i) + c^*(i) \\ s.t.\ c(i) = \left(\frac{p(i)}{P}\right)^{-\sigma} nC \\ \quad c^*(i) = \left(\frac{q(i)}{P^*}\right)^{-\sigma} (1-n)C^* \end{cases}$$

- Optimal prices are thus given by:

$$\begin{aligned} p(i) &= \frac{\sigma}{\sigma - 1}\frac{W}{A} \\ q(i) &= \frac{\sigma}{\sigma - 1}\frac{W}{Ae} \end{aligned}$$

- Under flexible prices, the law of one price holds: $p(i) = eq(i)$.

Firms' behaviour (2)

- PCP firms solve the following program:

$$\begin{cases} \max_{p(i)} \pi^{PCP}(i) = p(i)c(i) + p(i)c^*(i) - \frac{W}{A}(c(i) + c^*(i) \\ s.t.\ c(i) = \left(\frac{p(i)}{P}\right)^{-\sigma} nC \\ \quad c^*(i) = \left(\frac{p(i)}{eP^*}\right)^{-\sigma} (1-n)C^* \end{cases}$$

- Optimal price is:

$$p(i) = \frac{\sigma}{\sigma - 1}\frac{W}{A}$$

- The law of one price holds under flexible prices and under sticky prices.

Aggregate prices

- PPP holds under flexible prices

$$P = \left[n \left(\frac{\sigma}{\sigma - 1} \frac{W}{A} \right)^{1-\sigma} + (1-n)s \left(e \frac{\sigma}{\sigma - 1} \frac{W^*}{A^*} \right)^{1-\sigma} (1-n)(1-s) \left(e \frac{\sigma}{\sigma - 1} \frac{W^*}{A^*} \right)^{1-\sigma} \right.$$

$$P^* = \left[ns \left(\frac{\sigma}{\sigma - 1} \frac{W}{Ae} \right)^{1-\sigma} + n(1-s) \left(\frac{1}{e} \frac{\sigma}{\sigma - 1} \frac{W}{A} \right)^{1-\sigma} (1-n) \left(\frac{\sigma}{\sigma - 1} \frac{W^*}{A^*} \right)^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$$

$$\Rightarrow \; P = eP^*$$

- PPP does not hold under sticky prices when some firms price in LCP:

$$\hat{P} = (1-n)(1-s)\hat{e}$$
$$\hat{P}^* = -n(1-s)\hat{e}$$
$$\Rightarrow \quad \hat{P} - \hat{P}^* = (1-s)\hat{e} \neq \hat{e}$$

Exchange-rate dynamics

$$\hat{e}(1-s) = (\hat{M} - \hat{M}^*) - \frac{1}{\epsilon}(\hat{C} - \hat{C}^*)$$

- Exchange rate depreciates in response to relative national money growth, and appreciates in response to relative national growth in real consumption.
- The size of s determines the magnitude of the departure from PPP and of the exchange-rate adjustment to shocks.

Conclusion

- Under flexible nominal prices, PTM has no aggregate implications for any kinds of shocks and PPP holds: $eP^* = P$
- Deviations from PPP are explained by the combination of sticky prices and PTM
- PTM as a reversed effect on the way exchange-rates adjust to monetary shocks

$\Rightarrow$ Important consequences on the way open economics adjust to asymmetric shocks.

- Limit: Incomplete ERPT explained by sticky prices $\rightarrow$ Full pass-through in the long-run $\rightarrow$ Empirical evidence rather suggests that ERPT is incomplete, even in the long-run $\rightarrow$ There must be some incentive to PTM, beyond the impact of SR ER fluctuations $\rightarrow$ Models in which firms have an incentive to PTM (Corsetti & Dedola, etc.)

Distribution Margins, Imported Inputs, and the Sensitivity of the CPI to Exchange Rates Campa & Goldberg (2006)

Motivation

- Border prices of traded goods are highly sensitive to exchange rates, but the CPI, and the retail prices of these goods, are more stable.
- The paper builds a model explaining these differences in exchange rate pass-through to import prices and consumer prices.

$\Rightarrow$ Important roles of local distribution margins and imported inputs in transmitting exchange rate fluctuations into consumption prices.

- Empirical analysis based on data for twenty-one OECD countries comparing distribution margins, imported inputs and weights in consumption of nontradables, home tradables and imported goods across countries and industries.

$\Rightarrow$ Calibration exercise allowing to compute the predicted ERPT into CPI for different countries (comparable with existing estimates)

Overview of results

⇒ While distribution margins damp the sensitivity of consumption prices of tradable goods to exchange rates, they also lead to enhanced pass through when nontraded goods prices are sensitive to exchange rates. Such price sensitivity arises because imported inputs are used in production of home nontradables.

- Calibration exercises show that, at under 5 percent, the United States has the lowest expected CPI sensitivity to exchange rates of all countries examined. On average, calibrated exchange rate pass through into CPIs is expected to be closer to 15 percent.

⇒ Consistent with empirical estimates of aggregate ERPTs

ERPT into import and consumer price indices

- Use quarterly data for the period 1975:1 to 2003:4
- Estimated equation:

$$\Delta p_{it} = \alpha \Delta e_{it} + \beta \Delta p_t^*$$

  where p is either the log of the import price index or the log of the CPI in country i, e is the effective exchange rate and p^* is a measure of foreign price. Under complete ERPT, $\alpha = 1$
- Add lags to account for partial price adjustments $\Rightarrow$ ERPT defined as the cumulative one-year impact from an exchange rate shock (LR ERPT)

Table 1: Exchange Rate Pass-through Elasticities into Import and Consumer Price Indices

Country	Pass-Through on Import Prices	Pass-through on Consumer Prices
Australia	0.67*+	0.09+
Austria	0.10	-0.09
Belgium	0.68	0.08+
Canada	0.65*+	-0.01+
Czech Republic	0.6*	0.60*+
Denmark	0.82*	0.16*+
Finland	0.77	-0.02+
France	0.98*	0.48*+
Germany	0.80*	0.07+
Hungary	0.78*	0.42*+
Ireland	0.06	0.08+
Italy	0.35+	0.03+
Japan	1.13*	0.11*+
Netherlands	0.84*	0.38*+
New Zealand	0.22+	-0.10*+
Norway	0.63*	0.08+
Poland	0.78*	0.59*+
Portugal	1.08*	0.60*+
Spain	0.70*	0.36*+
Sweden	0.38*+	-0.11+
Switzerland	0.93*	0.17*+
United Kingdom	0.46*+	-0.11+
United States	0.42*+	0.01+
Average	0.64	0.17

* (+) indicates exchange rate pass through significantly different from zero (one) at a 5 percent confidence level. Most data are quarterly, spanning 1975 through early 2003. Data sources: nominal exchange rate and consumer prices come from the IFS; import price comes from the OECD. Specific start and end dates by country are detailed in the data appendix. Long-run elasticities (four quarters) shown.

ERPT into import and consumer price indices (3)

- Difference between the import price and the CPI responsiveness to exchange rate movements for almost all OECD countries $\Rightarrow$ Pass through into border prices far exceeds pass through into the CPI.
- The (unweighted) average pass through elasticity is 0.64 for import prices. It is significantly different from zero in seventeen of the twenty-three countries. VERIFIER LA DEFINITION DES PRIX
- The average pass-through into consumer prices is 0.17 over the long run. These averages mask huge cross-country differences in CPI sensitivity. Nevertheless, the hypothesis that the pass through to CPIs is smaller than one can be rejected for all but one country. In general, larger countries tend to have lower levels of estimated pass through into the CPI.

Intuition for the low ER sensitivity of CPIs

- CPIs aggregate traded and non-traded goods. Only tradables are expected to be sensitive to ERs
- The retail price of traded goods contains non-traded components: Expenditures on transportation, storage, finance, insurance, wholesaling, and retailing add local-value-added components to the final consumption value of imports.
- There can be "double marginalization": distributors may have an incentive to absorb some of the exchange-rate fluctuations in order to maintain stable prices or expand market share at the retail level

Hypotheses

- Two country model with wage stickiness (wages are sticky over the relevant pricing horizon)
- Imported inputs in the production of tradable and nontradable goods $\Rightarrow$ Producing costs sensitive to exchange rates
- Distribution costs in terms of nontradables $\Rightarrow$ Failure of purchasing power parity due to the presence of local transaction and distribution costs.

Hypotheses (2): Consumption structure

- C.E.S. utility functions over nontraded and traded goods consumption:

$$C = \left[\alpha^{\frac{1}{\Phi}} C_T^{\frac{\Phi-1}{\Phi}} + (1-\alpha)^{\frac{1}{\Phi}} C_N^{\frac{\Phi-1}{\Phi}} \right]^{\frac{\Phi}{\Phi-1}}$$

- Home (h) and foreign (f) tradable goods consumption are imperfect substitutes:

$$C_T = \left[\alpha_T^{\frac{1}{\Phi_T}} C_{TH}^{\frac{\Phi_T-1}{\Phi_T}} + (1-\alpha_T)^{\frac{1}{\Phi_T}} C_{TF}^{\frac{\Phi_T-1}{\Phi_T}} \right]^{\frac{\Phi_T}{\Phi_T-1}}$$

- Both sectors produce a continuum of varieties with similar elasticities of substitution:

$$C_N = \left[\int_0^1 c(n)^{\frac{\theta-1}{\theta}} dn \right]^{\frac{\theta}{\theta-1}}$$

$$C_{TH} = \left[\int_0^1 c(h)^{\frac{\theta-1}{\theta}} dh \right]^{\frac{\theta}{\theta-1}}$$

Hypotheses (3): Supply side

- The marginal cost has two components: the production cost and the distribution cost.
- Bringing one unit of traded goods to consumers requires units of a basket of differentiated nontraded goods:

$$MC_t(h) = PC_t(h) + m_t(h)P_{Nt}$$

with $PC_t(h)$ the cost of producing variety h at producer level, $m_t(h) = \left[\int_0^1 m_n^{\frac{\theta-1}{\theta}} dn\right]^{\frac{\theta}{\theta-1}}$ the basket of nontraded inputs and P_{Nt} the ideal price index for non-traded inputs.

- Per unit production requires imported input share $\mu_t(h)$ on home tradable goods and $\mu_t(n)$ on home nontradable goods

Hypotheses (4): Supply side

- Maximizing profits given optimal demands gives:

$$
\begin{aligned}
p_t(h) &= \frac{\theta}{\theta-1}\left[\mu_t(h)\frac{e_t W^*}{Z_F} + \frac{W}{Z_H} + m_t(h)P_{Nt}\right] \\
p_t(n) &= \frac{\theta}{\theta-1}\left[\mu_t(n)\frac{e_t W^*}{Z_F} + \frac{W}{Z_N}\right] \\
p_t(f) &= \frac{\theta}{\theta-1}\left[\frac{e_t W^*}{Z_F} + m_t(f)P_{Nt}\right]
\end{aligned}
$$

  with Z exogenous sector-specific praoductivity parameters and e_t domestic currency price of foreign currency.

- No imported inputs in the production of foreign varieties?
- Imported inputs are homogeneous?
- No distribution costs for nontradables? (Useless in explaining ERPT)

Hypotheses (5): Supply side

- Possibility of double marginalization:
  The distribution margin $m_t(i),\ i = h/f$ is possibly sensitive to exchange rates $\Rightarrow$ Allows for possible deviations from the competitive distribution sector assumed in the model
- Exchange rate sensitivity of import shares:
  Imported input shares, $\mu_t(i),\ i = h/n$ can be sensitive to exchange rate movements $\Rightarrow$ Incomplete ERPT on imported inputs or sensitivity of the local content to exchange rates.

Pass-through rates at the good level

$$\eta_e^{p(n)} = \frac{\theta}{\theta-1}(1+\eta_e^{\mu(n)})\frac{\mu_t(n)\frac{e_t W^*}{Z_F}}{p_t(n)}$$

$$\eta_e^{p(h)} = \frac{\theta}{\theta-1}\left[(1+\eta_e^{\mu(h)})\frac{\mu_t(h)\frac{e_t W^*}{Z_F}}{p_t(h)} + (\eta_e^{m(h)}+\eta_e^{P(n)})\frac{m_t(h)P_{Nt}}{p_t(h)}\right]$$

$$\eta_e^{p(f)} = 1-\frac{\theta}{\theta-1}\frac{m_t(f)P_{Nt}}{p_t(f)}\left[1-(\eta_e^{m(f)}+\eta_e^{P(n)})\right]$$

Remark: Implicitely assumes that all η are constant over time.

Pass-through rates at the good level (2)

- Non-traded goods are sensitive to exchange rate changes if producers use imported inputs. Incomplete pass-through if the production structure allows substitution away from these inputs when they are more expensive ($\eta_e^{\mu(n)} < 0$)
- Home tradables prices respond to exchange rate shocks through two channels: imported inputs in production and distribution margins.
  - Distribution expenditures vary because nontradables prices respond to exchange rates and because distributors strategically adjust their markups when the prices of competing imported varieties change ($\eta_e^{m(h)} \neq 0$)
  - Incomplete pass-through into imported input costs if home tradables producers can substitute away from the imported inputs ($\eta_e^{\mu(h)} < 0$)
- The consumer price of foreign goods react to exchange rates. ERPT is incomplete in the presence of a distribution sector damping the import content of this consumption good. Magnitude of this damping depends on whether distributor markups ($\eta_e^{m(f)} \neq 0$) and nontraded goods prices respond to exchange rates ($\eta_e^{P(n)} \neq 0$)

Pass-through rates at the good level (3)

- The price elasticity is smaller when elasticities of substitution among goods are larger
- ERPT also varies according to productivity conditions ("state contingent component of markups" as in Corsetti & Dedola, 2003): higher Z_H relative to $Z_N \rightarrow$ larger pass-through

Pass-through rates at the aggregate level

- Price indices:

$$
\begin{aligned}
P_t &= \left[\alpha P_{Tt}^{1-\Phi} + (1-\alpha) P_{Nt}^{1-\Phi}\right]^{\frac{1}{1-\Phi}} \\
P_{Tt} &= \left[\alpha_T P_{THt}^{1-\Phi_T} + (1-\alpha_T) P_{TFt}^{1-\Phi_T}\right]^{\frac{1}{1-\Phi_T}} \\
P_{Nt} &= \left[\int_0^1 p_t(n)^{1-\theta} dn\right]^{\frac{1}{1-\theta}} \\
P_{THt} &= \left[\int_0^1 p_t(h)^{1-\theta} dh\right]^{\frac{1}{1-\theta}} \\
P_{TFt} &= \left[\int_0^1 p_t(f)^{1-\theta} df\right]^{\frac{1}{1-\theta}}
\end{aligned}
$$

Pass-through rates at the aggregate level (2)

$\Rightarrow$ Aggregate pass-through:

$$\eta_e^P \equiv \frac{\partial P/P}{\partial e/e} = \alpha \left(\frac{P_{Tt}}{P_t}\right)^{1-\Phi} \eta_e^{P_T} + (1-\alpha)\left(\frac{P_{Nt}}{P_t}\right)^{1-\Phi} \eta_e^{P_N}$$

$$\eta_e^{P_T} = \alpha_T \left(\frac{P_{HTt}}{P_{Tt}}\right)^{1-\Phi_T} \eta_e^{P_{HT}} + (1-\alpha_T)\left(\frac{P_{FTt}}{P_{Tt}}\right)^{1-\Phi_T} \eta_e^{P_{FT}}$$

$$\eta_e^{P_N} = \int_0^1 \left(\frac{p_t(n)}{P_{Nt}}\right)^{1-\theta} \eta_e^{p(n)} dn = \eta_e^{p(n)}$$

$$\eta_e^{P_{HT}} = \int_0^1 \left(\frac{p_t(h)}{P_{HTt}}\right)^{1-\theta} \eta_e^{p(h)} dh = \eta_e^{p(h)}$$

$$\eta_e^{P_{FT}} = \int_0^1 \left(\frac{p_t(f)}{P_{HFt}}\right)^{1-\theta} \eta_e^{p(f)} df = \eta_e^{p(f)}$$

Pass-through rates at the aggregate level (3)

- Aggregate CPI pass-through is a weighted average of pass-through elasticities into traded and nontraded prices
- Aggregate CPI pass-through depends on relative wages, relative productivities, elasticities of substitution between T and NT good, between domestic and foreign tradables and between varieties, imported input use, distribution margins and the shares of each type of good in aggregate consumption

Empirical evidence (1)

- Required data: distribution margins, demand elasticities, imported input use, consumption shares, and relative prices within countries
- Coverage: 21 OECD countries, 30 industries,
- Sources: I/O Tables. Sector-specific data
  - → Imported input share= Value of imported inputs / (Total value of inputs)
  - → Distribution margin=(Expenditures on distribution margins+transportation costs)/Total supply (at producer or basic prices)
  - → Share of tradables in consumption computed using an ad-hoc classification of sectors into T and NT goods
- Demand elasticities calibrated using existing estimates: θ between 4 and 10 (pass-through higher for lower demand elasticities), $\Phi = 2.27$

Table: Industry Patterns of Imported Input Use and Distribution Margin Shares

Product	Imported Inputs			Distribution Margins Total Margins		
	Average	Max.	Min.	Average	Max.	Min.
01 Products of agriculture, hunting and related services	17.25	54.47	6.33	16.40	27.52	1.67
02 Products of forestry, logging and related services	13.93	38.73	1.57	16.52	34.87	0.00
05 Fish and other fishing products; services incidental to fishing	20.33	60.64	2.74	23.72	54.43	2.42
10 Coal and lignite; peat	13.39	50.79	0.00	14.69	45.90	0.00
11 Crude petroleum and natural gas, services incidental to oil and gas extraction, excluding surveying	21.67	75.15	0.00	4.91	17.30	0.00
12+13 Uranium, thorium and metal ores	1.04	9.93	0.00	3.21	7.69	0.00
14 Other mining and quarrying products	15.67	60.08	0.00	19.40	43.20	0.00
15 Food products and beverages	21.12	48.27	5.74	19.67	29.67	8.96
16 Tobacco products	20.45	34.97	10.20	14.75	32.27	3.05
17 Textiles	31.74	55.68	0.00	20.54	38.53	7.95
18 Wearing apparel; furs	46.50	75.15	22.57	32.61	61.52	11.29
19 Leather and leather products	50.27	87.59	11.26	29.06	70.35	10.28
20 Wood and wood products	48.06	82.10	13.53	13.40	28.00	3.13
21 Pulp, paper and paper products	27.84	47.91	14.13	13.68	24.32	4.58
22 Printed matter and recorded media	41.68	77.97	16.02	15.98	26.40	7.10
23 Coke, refined petroleum products and nuclear fuel	23.62	47.42	10.52	13.53	40.54	4.67
24 Chemicals, chemical products and man-made fibers	67.28	90.92	0.00	16.80	27.30	3.46
25 Rubber and plastic products	43.56	67.96	19.90	13.61	28.01	5.14
26 Other non metallic mineral products	46.41	76.17	23.20	17.02	24.71	5.89
27 Basic metals	26.35	53.98	6.94	10.35	22.51	3.90
28 Fabricated metal products, except machinery and equipment	45.50	76.51	23.25	13.70	29.88	6.98
29 Machinery and equipment n.e.c.	34.57	76.22	17.83	14.04	31.77	4.35
30 Office machinery and computers	39.73	75.17	16.93	17.86	46.05	2.60
31 Electrical machinery and apparatus n.e.c.	56.43	98.42	34.98	12.64	24.23	2.55
32 Radio, television and communication equipment and apparatus	44.53	82.93	19.58	14.52	54.05	2.78
33 Medical, precision and optical instruments; watches and clocks	56.79	97.98	21.59	17.82	37.08	6.54
34 Motor vehicles, trailers and semi-trailers	43.08	72.86	18.82	13.45	23.15	6.40
35 Other transport equipment	50.96	83.22	16.86	6.76	26.38	1.44
36 Furniture; other manufactured goods n.e.c.	43.35	70.66	18.93	27.14	50.30	7.94

* Product names given with CPA Codes (Classification of Products by Activity). The margins represent the average of the wholesale and retail and transportation margins. Margins are calculated as: distribution margins divided by output at purchasers or final prices "Average Country Distribution Margins" are calculated as the sum of all non-negative distribution margins in a country's data, divided by the sum of all output from all industries (except those with negative margin numbers). Imported Input share is calculated as the average of the imported input share for each industry . n.e.c. means not elsewhere classified. The sample included are the countries and years reported in the first two columns of table 4.

Empirical evidence (3)

- Distribution margins vary considerably across industries and coutries
- There are common patterns across countries in the incidence of high and low margins for industries
- Distribution margins are quite high (+20%)
- About 90% of distribution margins can be attributed to the wholesale and retail components / less than 10% for transportation costs (except in some of the mining and extractive ressource industries)
- Total distribution margins on household consumption goods are much larger than those applied to investment or export goods (between 32 and 50% depending on the considered country)
- Industries involved in agriculture and commodity production have much lower shares of imported inputs than industries in the manufacturing sector
- The dispersion of imported inputs into production also differs significantly by country (between 8.2% in the US to 49% in Ireland, on average)

Empirical evidence (4)

- Some of the countries have multiple years of margin data that can be used for time-series panel construction and testing the exchange-rate sensitivity of distribution margins.
- Estimated equation:

$$\Delta m_t^c = \alpha_t + \alpha_c + \alpha_c \Delta X_t^c + \varepsilon_t^c$$

  with α_c and α_t country- and time-fixed effects, X_t^c country-specific exchange rates
- Remark: Estimated elasticities are lower bounds as: i) total distribution margins are expected to be less sensitive than retail and wholesale distribution margins, ii) Neglect the cross-sector heterogeneity, iii) Neglect the heterogeneity of distribution margins between home and imported varieties

Table: Sensitivity of Distribution Margins to Exchange Rates

	Nominal			Real		
Elasticity	**-0.359***	-0.257	-0.315	**-0.477****	**-0.476****	**-0.453****
t-stat	*1.78*	*0.96*	*1.32*	*2.99*	*2.15*	*2.45*
country	no	yes	no	no	yes	no
year	no	no	yes	no	no	yes
R-squared	0.06	0.14	0.17	0.18	0.24	0.27
Number Obs.	37	37	37	37	37	37

The dependent variable is the distribution margin for final demand for the following countries: Belgium, Denmark, France, Germany, Italy, Spain, UK and U.S. for the period 1995 to 2001, except for the U.S. in which the data goes from 1995 to 2002. The nominal and real effective exchange rates are the reu and neu measures from the IMF, International Financial Statistics database.

*significant at the 10 percent level **Significant at the 5 percent level

Home currency depreciations are associated with lowered distribution margins ($\eta_e^m < 0$)

Table 7: Trade and Imported Input Shares

Country	I-O year	Imports to Tradables $1-\alpha_T$	Tradables to Consumption α	Imported inputs relative to costs in tradable production μ(h:e)	Imported inputs relative to costs in nontradables μ(n:e)
Australia†*	2000/01	0.27	0.31	0.18	0.09
Austria	2000	0.59	0.33	0.43	0.15
Belgium	2000	0.55	0.34	0.48	0.15
Denmark	2000	0.59	0.28	0.33	0.10
Estonia	1997	0.57	0.59	0.42	0.22
Finland	2002	0.42	0.26	0.29	0.10
France	2000	0.24	0.38	0.20	0.08
Germany	2000	0.33	0.36	0.27	0.09
Greece	1998	0.57	0.39	n.a.	n.a.
Hungary*	2000	0.34	0.43	0.41	0.22
Ireland	1998	0.47	0.41	0.49	0.35
Italy	2000	0.26	0.40	0.24	0.09
Netherlands	2001	0.57	0.26	0.41	0.14
New Zealand*	1995/96	0.31	0.38	0.27	0.07
Norway	2002	0.46	0.34	0.25	0.14
Poland	2000	0.25	0.47	0.24	0.07
Portugal	1999	0.45	0.42	0.37	0.14
Spain	1995	0.25	0.35	0.22	0.08
Sweden	2000	0.47	0.26	0.35	0.16
United Kingdom	1995	0.34	0.34	0.25	0.10
United States	1997	0.20	0.25	0.10	0.03

* These data are computed from individual country-specific source data, based on purchasers prices. The other countries presented in the table have shares computed using a harmonized OECD database, with valuations using basic prices. n.a. = not available.

† For Australia the ratio of imported inputs in the production of tradables and nontradables refer to 1994/95 I-O benchmark tables from the OECD.

Cross-country heterogeneity, Tradable share $\approx$ 35%, Imports share in tradables $\approx$ 25 to 35%, Share of imported inputs in the production of nontraded goods $\approx$ 10%

Empirical evidence (7)

- Calibration:
  - $\eta_e^{\mu(n)} = \eta_e^{\mu(h)} = 0/-.10 \rightarrow$ Either ER shocks have no effect on the volume of imported inputs used (table) or a home currency depreciation of 1% decreases imported input share by .10%
  - $\eta_e^m = 0/-.50 \rightarrow$ in response to a 1% home currency depreciation, distributors can either leave margins on home tradables unchanged, or lower margins by 0.50 percent

Table: Calibrated Price Elasticities with Respect to Exchange Rates

	$\eta^{p(n),e}$ nontraded goods prices		$\eta^{p(h),e}$ home tradables prices		$\eta^{p(f),e}$ imported goods prices			
	θ=4	θ=10	θ=4	θ=10	θ=4		θ=10	
					$\eta^{m(f),e}$ =0	$\eta^{m(f),e}$ = -0.5	$\eta^{m(f),e}$ =0	$\eta^{m(f),e}$ = -0.5
Australia	0.12	0.10	0.31	0.25	0.52	0.25	0.59	0.36
Austria	0.20	0.17	0.69	0.56	0.52	0.22	0.59	0.34
Belgium	0.20	0.17	0.74	0.60	0.63	0.40	0.68	0.49
Denmark	0.13	0.11	0.53	0.43	0.47	0.16	0.54	0.29
Estonia	0.30	0.25	0.69	0.55	0.70	0.49	0.73	0.56
Finland	0.14	0.11	0.47	0.38	0.42	0.09	0.51	0.23
France	0.11	0.09	0.31	0.25	0.60	0.38	0.66	0.48
Germany	0.13	0.10	0.43	0.35	0.53	0.26	0.60	0.38
Greece	0.20	0.17	0.63	0.51	0.60	0.35	0.65	0.44
Hungary	0.29	0.24	0.70	0.56	0.65	0.40	0.68	0.48
Ireland	0.46	0.39	0.86	0.69	0.75	0.52	0.76	0.57
Italy	0.12	0.10	0.39	0.31	0.50	0.23	0.58	0.35
Netherlands	0.19	0.16	0.68	0.55	0.46	0.12	0.53	0.25
New Zealand	0.09	0.08	0.41	0.34	0.50	0.23	0.58	0.35
Norway	0.19	0.16	0.44	0.35	0.55	0.28	0.61	0.38
Poland	0.09	0.08	0.36	0.30	0.62	0.41	0.68	0.50
Portugal	0.19	0.15	0.57	0.47	0.64	0.42	0.69	0.51
Spain	0.11	0.09	0.35	0.28	0.55	0.30	0.62	0.41
Sweden	0.22	0.18	0.56	0.46	0.63	0.40	0.68	0.48
U. Kingdom	0.14	0.12	0.42	0.34	0.44	0.12	0.52	0.25
United States	0.04	0.04	0.16	0.13	0.45	0.17	0.54	0.31

Note: Assumes: Greece μ(h)=0.40, μ(n)=0.15; for Australia assumes the distribution margin shares of New Zealand; the share of imported inputs in production does not change with exchange rate changes, that the elasticities on home tradeables distribution margins are 0; and normalizes ew*/Zf=1.

Empirical evidence (9)

- Lower demand elasticities imply higher mark-ups and higher ERPT
- ERPT into home tradables is higher than ERPT into nontradables as the share of imported inputs is higher
- Cross-country differences in imported input generate strong heterogeneity in ERPT coefficients (compare Ireland and the US)
- Adding a distribution sector with local costs drives a large wedge between complete pass through and the calibrated pass-through for imported goods prices
- Double marginalization further reduces the pass-through

Table: U.S. Exchange Rate Pass-Through Elasticities, under alternative assumptions

assumptions	(1)	(2)	(3)	(4)	(5)	(6)	(7)
θ	4	4.00	4.00	4.00	4.00	4.00	4.00
$\eta^{\mu(n),e} = \eta^{\mu(h),e}$	0	0.00	0.00	0.00	-0.10	-0.10	-0.10
$\eta^{m(h),e}$	0	0.00	0.10	0.10	0.00	0.10	0.10
$\eta^{m(f),e}$	0	-0.50	0.00	-0.50	-0.50	0.00	-0.50
ew*/zf	1	1.00	1.00	1.00	1	1.00	1.00
results							
$\eta^{p(n),e}$	0.040	0.040	0.040	0.040	0.036	0.036	0.036
$\eta^{p(h),e}$	0.156	0.156	0.213	0.213	0.141	0.198	0.198
$\eta^{p(f),e}$	0.453	0.168	0.453	0.168	0.165	0.450	0.165
$\eta^{cpi,e}$	0.084	0.070	0.095	0.081	0.063	0.089	0.075

Empirical evidence (10)

- when the distribution margin on imported goods is sensitive to exchange rates, ERPT into consumption prices of imports decreases.
- when the distribution margin on home tradables is sensitive to exchange rates, ERPT into home tradables is increased
- allowing for substitution out of some imported inputs directly reduces pass through into nontraded goods prices and home tradables prices + additional indirect downward effect on pass through of home tradables and imported goods by reducing transmission of exchange rates through distribution sector costs.

Table: Exchange Rate Pass through into the CPI

	Weight on Price Elasticities in the CPI Elasticity			Exchange Rate Pass Through into CPI				
				Estimated	Calibrated, θ=4			
	$\eta^{p(h),e}$ weight (1)	$\eta^{p(f),e}$ weight (2)	$\eta^{p(n:e),e}$ weight (3)	Reproduced From Table 1 (4)	Assuming $\eta^{m(f:e),e}=0$ (5)	Assuming $\eta^{m(f:e),e}$ =-.5 (6)	Assuming estimated import price pass through and assuming $\eta^{m(f:e),e}$ = 0 (7)	-0.5 (8)
Australia	0.23	0.08	0.69	0.09*	0.20	0.17	0.13	0.12
Austria	0.14	0.20	0.67	-0.09	0.33	0.27	0.03	0.03
Belgium	0.15	0.19	0.66	0.08+	0.36	0.32	0.25	0.22
Denmark	0.11	0.16	0.72	0.16*+	0.23	0.18	0.19	0.15
Estonia	0.25	0.34	0.41		0.53	0.46		
Finland	0.15	0.11	0.74	-0.02 +	0.22	0.18	0.17	0.14
France	0.29	0.09	0.62	0.48*+	0.21	0.19	0.21	0.19
Germany	0.24	0.12	0.64	0.07+	0.25	0.22	0.20	0.17
Greece	0.17	0.23	0.61		0.36	0.31		
Hungary	0.28	0.14	0.57	0.42*+	0.46	0.42	0.36	0.33
Ireland	0.21	0.19	0.59	0.08+	0.61	0.56	0.04	0.03
Italy	0.29	0.10	0.60	0.03+	0.24	0.21	0.08	0.07
Netherlands	0.11	0.15	0.74	0.38*+	0.29	0.24	0.24	0.20
New Zealand	0.26	0.12	0.62	-0.10*+	0.23	0.19	0.05	0.04
Norway	0.19	0.16	0.66	0.08+	0.29	0.25	0.18	0.16
Poland	0.35	0.12	0.53	0.59*+	0.25	0.23	0.20	0.18
Portugal	0.23	0.19	0.58	0.60*+	0.36	0.32	0.39	0.35
Spain	0.26	0.09	0.65	0.36*+	0.21	0.19	0.15	0.13
Sweden	0.14	0.12	0.74	-0.11 +	0.32	0.29	0.12	0.11
United Kingdom	0.23	0.11	0.66	-0.11+	0.24	0.20	0.11	0.09
United States	0.20	0.05	0.75	0.01+	0.08	0.07	0.04	0.03
average	**0.21**	**0.15**	**0.64**	**0.16**	**0.30**	**0.26**	**0.15**	**0.13**

Empirical evidence (12)

- nontraded goods have the largest weights in CPIs across all countries (between 0.41 and 0.75/0.11-0.30 for home tradables/ 0.05-0.34 for imported goods)
- Calibrated exchange rate pass through into the CPI between 30 percent and 13 percent, on average, depending on what is assumed about the double-marginalization process and what is assumed on exchange rate pass through into import prices at the border.
- Strong cross country differences: highest calibrated exchange rate pass throughs in Ireland, Estonia, and Hungary ($\approx 40\%$)/ lowest calibrated pass throughs for the United States. Predictions are correlated with actual (noisy) estimates.
- Crucial effect of imported inputs, affecting nontradable prices (that have the highest share in CPIs) and also tradable prices through distribution margins $\rightarrow$ Account for the vast majority of the sensitivity of CPIs to exchange rates in the model
- Distribution costs decrease the pass-through of exchange rates into CPIs by adding local content to imported consumption goods, thereby reducing the share of the final consumption good directly linked to border prices, and through the double marginalization

Conclusion

- ERPT into CPIs depends on the role that tradables have in the economy (consumption and imported inputs)
- Pass-through into nontraded goods prices and home tradable prices also contribute to overall CPI pass-through
- Distribution margins are important for damping border price pass through into consumption prices, but also enhance pass through because distribution expenditure for all tradables is sensitive to the nontradable sector's reliance on imported inputs.
- Limits:
  - Model that relies on Dixit-Stiglitz preferences: No incentive to PTM $\rightarrow$ Complete ERPT into import prices (measured at the border) $\rightarrow$ Inconsistent with empirical evidence $\rightarrow$ Possible solution: Quasi linear demand functions, oligopolistic competition (Atkeson & Burstein, 2006)
  - Possible effects via the extensive margin of trade (Berman, Martin & Mayer, 2008)