(4/27/09)

Topic 7: Law of One Price and International Goods Market Integration;

Part1: Empirical evidence on the Law of One price

Motivation:

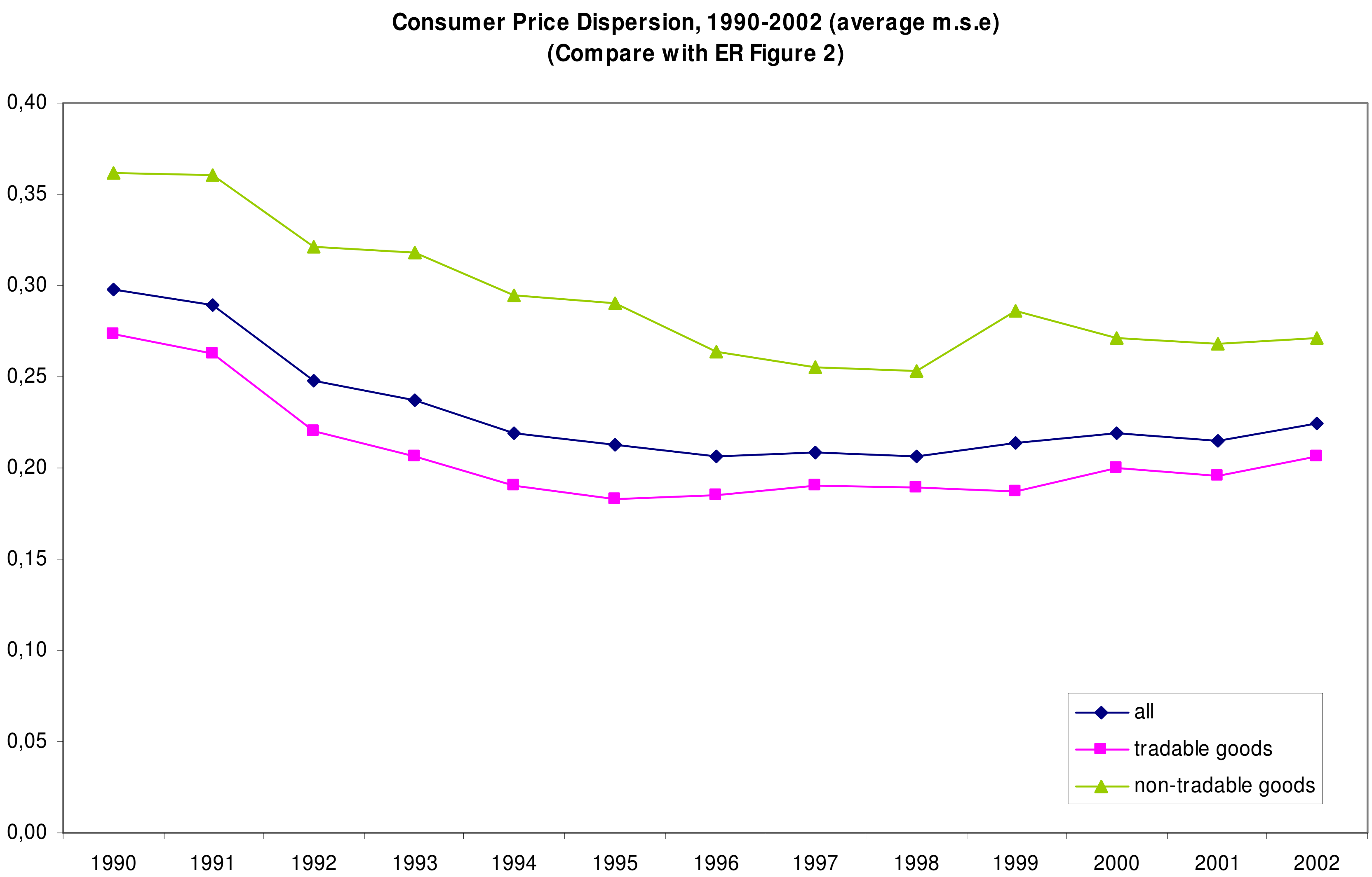
- Recall that four of the five reasons for failures in PPP deal with failures in the law of one price:
  - nontraded goods
  - trade barriers
  - imperfect competition
  - sticky prices

- Even in Europe, where monetary union is intended to create price transparency and promote integration of goods markets, there is significant price dispersion.

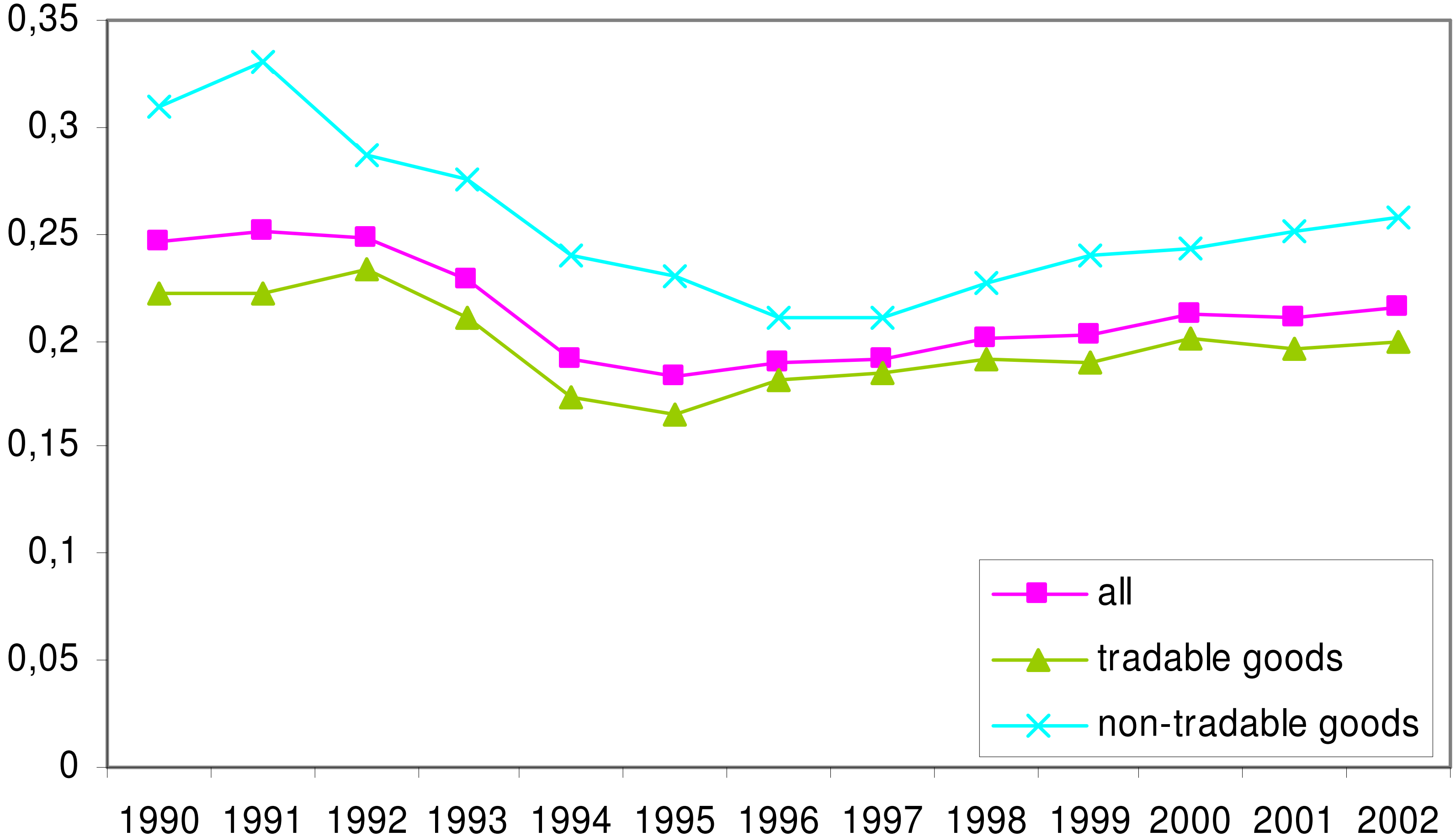
a) Some evidence reported in Bergin and Glick (JIE 2007)

Data:
- Source: Economist Intelligence Unit
- Annual observations, starting from 1990
- 138 goods in hundreds of locations (just EU)
- Inspectors visit retail locations and record prices

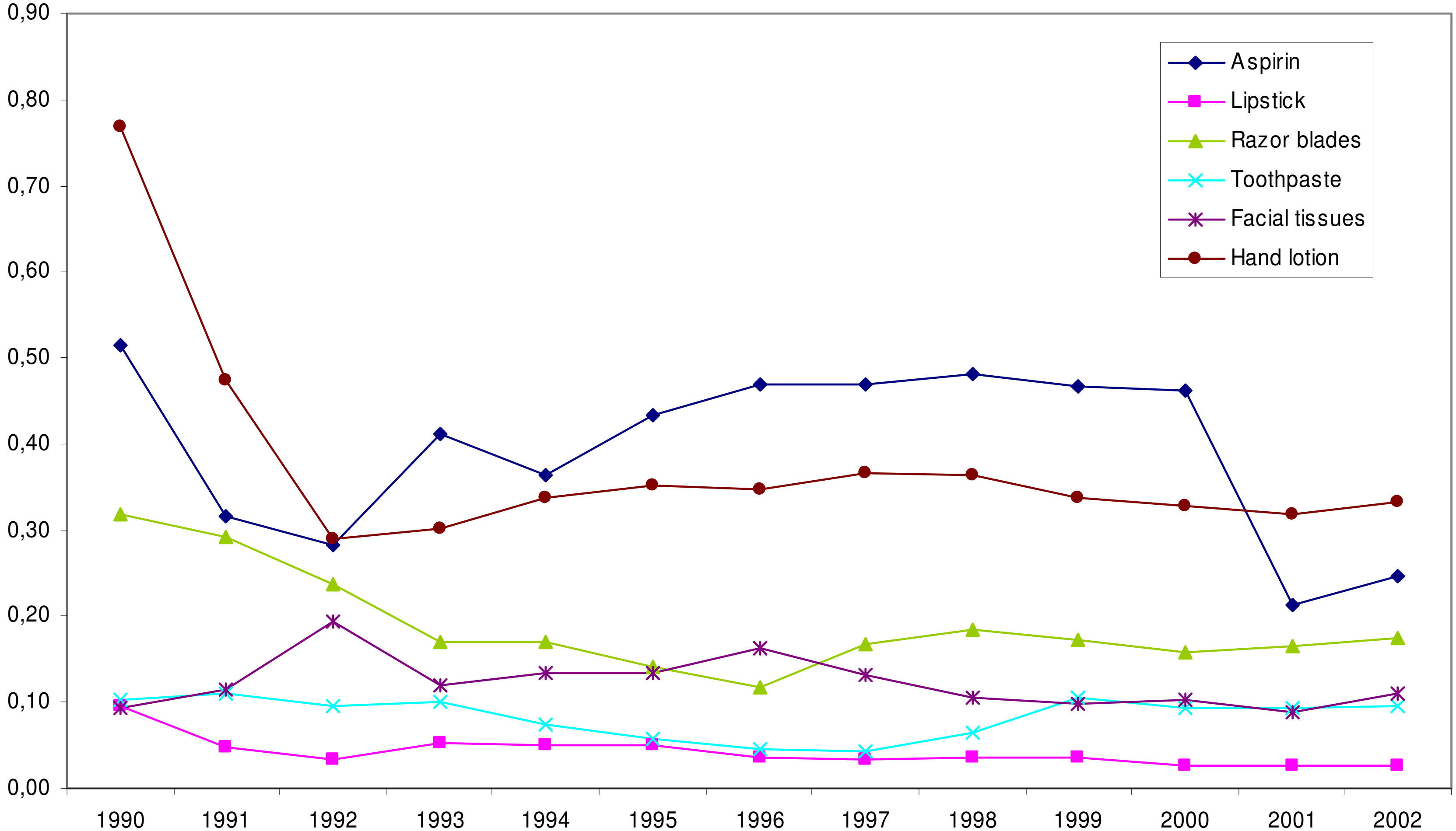
Measurement of dispersion: mean squared error
- for a good (i) compute the average price level of that good across locations (j): $\overline{x}_i$
- for each country compute the squared deviation from $\overline{x}_i$.
- Compute the average across the countries: $\frac{1}{n}\sum_{j=1}^{n}\left(x_{ij}-\overline{x}_i\right)^2$
- Compute average of this for various groupings of goods.

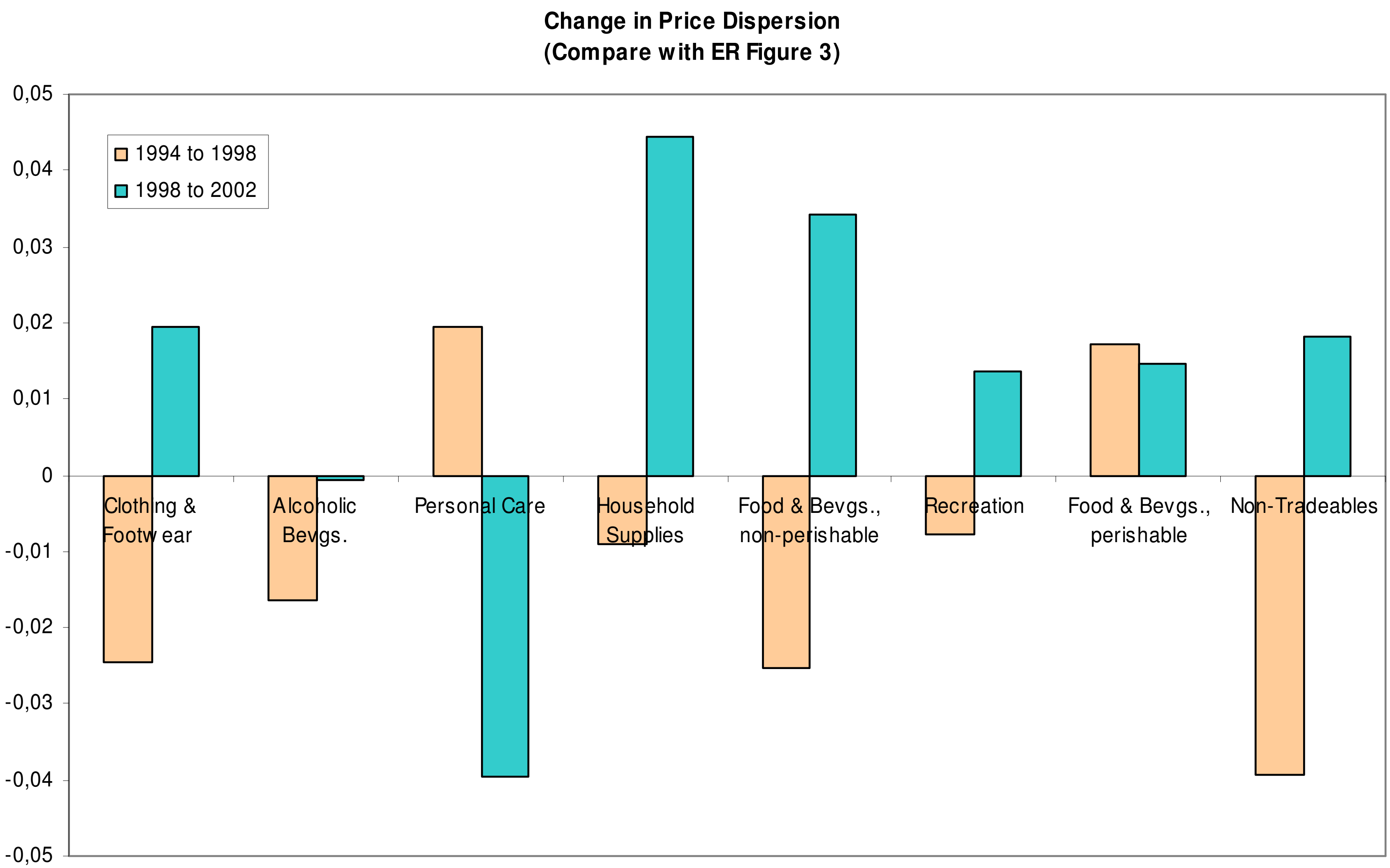

Consumer Price Dispersion, 1990-2002 (average m.s.e)
(Compare with ER Figure 2)
0,40
0,35
0,30
0,25
0,20
0,15
0,10
0,05
0,00
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
all
tradable goods
non-tradable goods

Frankfurt
Consumer Price Dispersion, 1990-2002 (average m.s.e)



Consumer Price Dispersion of Personal Care Goods, 1990-2002 (m.s.e)
(Compare with ER Figure 2)





Note: Negative values indicate a decline in dispersion.

b) **Crucini et al. (AER 2005):**

Objective:

Study price dispersion within the European Union, and test to what degree price dispersion is related to nontradedness of the good and also of its inputs.

Data:

- From Eurostat survey every five years (1975-1990).
- Coverage grows over time from 9 counties in 1975 to 13 in 1990, and from 658 in 1975 to 1896 in 1990.
- Some are branded goods, so are same item; others are a broader category.
- Many missing observations for some countries – eliminate goods with too many missing observations.

Findings:

- For each good (i) in a country (j), compute the deviation of the price from the European-wide average (all in logs):

$$q_{ij} \equiv \log P_{ij} - \frac{1}{M}\sum_{j=1}^{M} \log P_{ij}$$

- Report the distribution of these price deviations across goods for a given country in each year. Figure 1 shows:

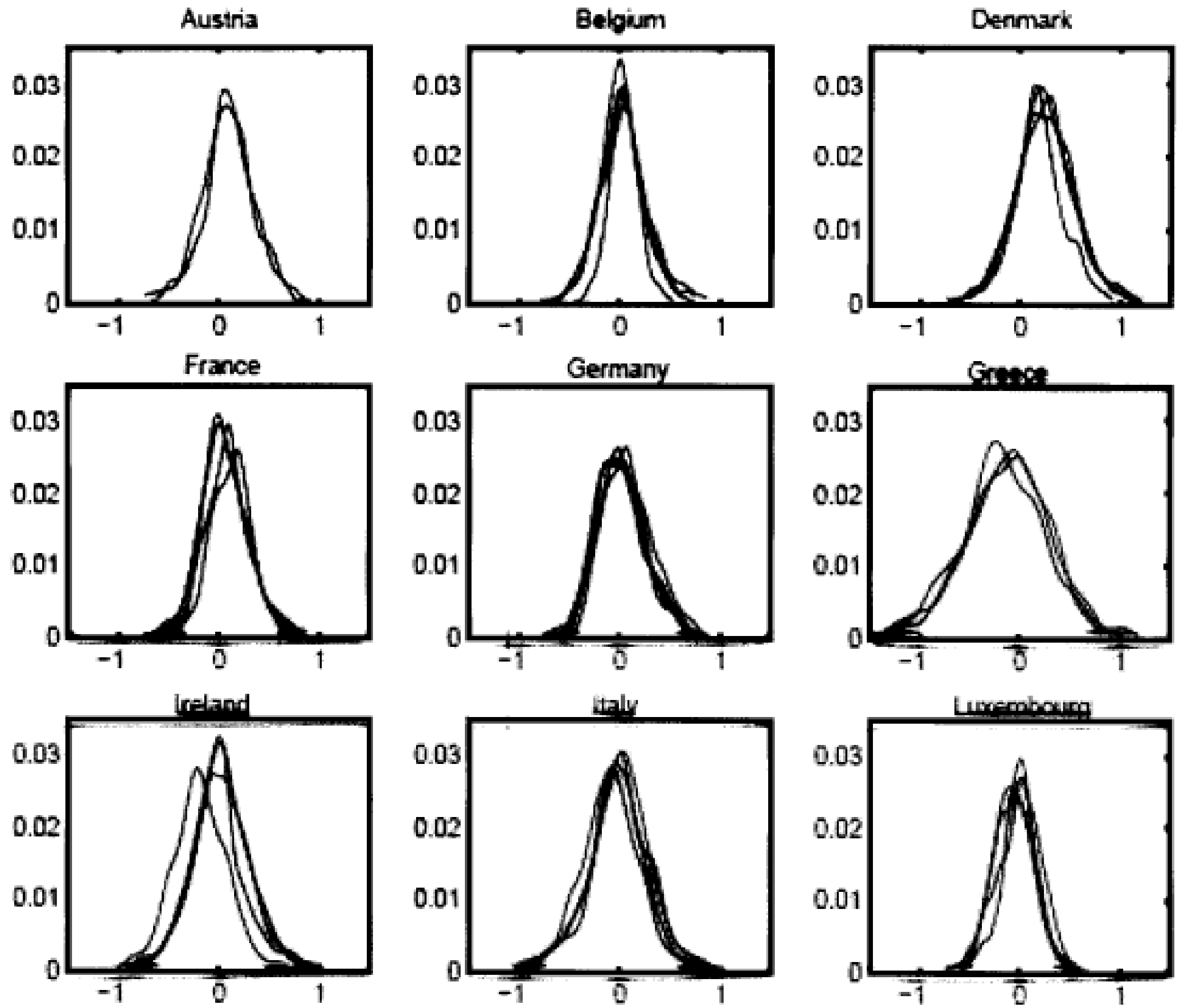
1) LOP deviations can be large: plus or minus 100 %

2) Poor countries tend to be more in the cheaper range

3) There are generally as many overpriced goods as underpriced goods in richer countries.

4) The distribution seems to not change much over time

Figure 1
Empirical Distributions of LOP Deviations



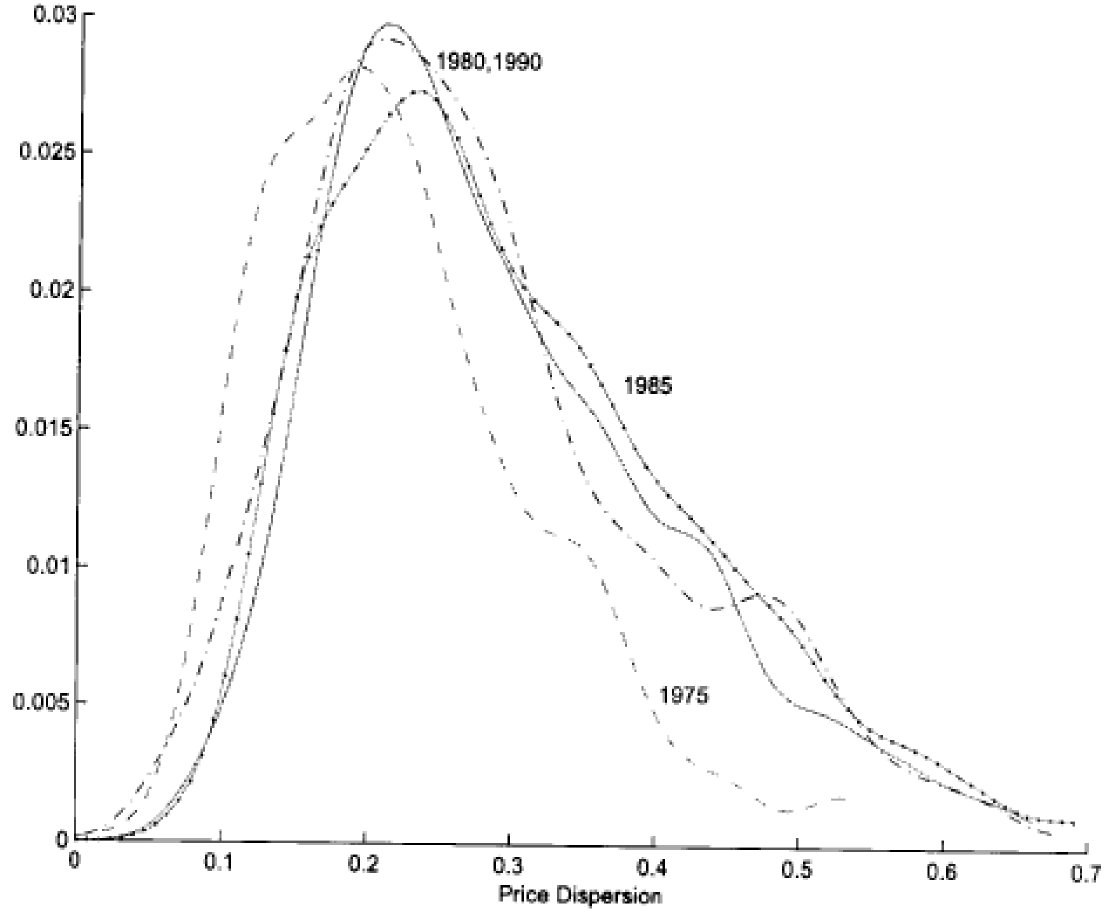
Cross sectional variance across countries for each good

- Compute the variance of the price deviations for a given class of goods (i) across all the countries: $\operatorname{var}\left(q_{ij} \mid i\right)$

- Plot the distributions of observations for this variance.

- Figure 3 shows the degree of dispersion differs much across different types of goods (from 2% to 80%)

Figure 3
Empirical Distributions of $Var(q_{ij}\,|\,j)^{1/2}$



Each line represents an estimate (for each year) of the density of $Var(q_{ij}\,|\,i)^{1/2}$, the standard deviation of the LOP deviation for good i across countries j.

- Investigate if degree of dispersion depends on <u>tradability</u>: Table 8 shows regression of dispersion on
  (1) share of nontraded inputs for the good, and
  (2) the negative of the traded share of good i.
- The nontraded inputs share comes from ratio of nontraded input costs to total costs, coming from UK 1988 input-output tables.
- Traded share is the ratio of total trade among the countries in the sample in a particular industry divided by total output of that industry across the same countries.
- Estimates imply that most tradable good has dispersion of 0.12, least tradable has dispersion 0.43 (big effect).
- Regressions indicate that nontradedness of the final good or its inputs are important for explaining LOP deviations

$$\sigma_i^2 = a + b\alpha_i^2 + c(1-\alpha_i)^2 x_i + \text{residuals}$$

Year	a	b	c	R_a^2	R_d^2
1975	0.083	0.299	0.090	0.433	0.120
	(0.006)	(0.115)	(0.013)		
1980	0.099	0.921	0.051	0.291	0.107
	(0.007)	(0.143)	(0.012)		
1985	0.115	0.791	0.059	0.319	0.106
	(0.006)	(0.118)	(0.008)		
1990	0.122	1.033	0.100	0.537	0.291
	(0.005)	(0.106)	(0.008)		
Pooled	0.102	0.868	0.062	0.417	0.129
	(0.003)	(0.064)	(0.005)		

Estimates of the parameters of the regression at the top of the page, based on equation (7) in the text. σ_i^2 denotes our good-specific measure of price dispersion: the sample variance of q_{ij} from equation (1) in the text. α_i denotes the non-traded input share for good i and x_i is (the negative of) the trade share of good i (see Section 3.1 for details). Standard errors in parentheses. Because our explanatory variables are averaged across different numbers of goods within industry groups, the residuals will be heteroskedastic. We therefore use a feasible GLS estimator (details are provided in the appendix). R_a^2 denotes the regression R^2 that results in

c) Engel (1999 JPE): student presentation

d) Betts and Kehoe (2006 JME): student presentation

Question for debate: To what degree are the puzzling movements of real exchange rates due to nontraded goods?

Part2: Border Effects on Price Dispersion

a) Engel and Rogers (1996 AER): Student presentation

b) Gorodnichenko and Tesar (2008 AEJ-Macro): Student presentation

Question for Debate: Are national borders important barriers to arbitrage?

Part3: Barcode Evidence on Price Dispersion

a) Broda and Weinstein (2008): Student presentation

b) Gopinath, Gourinches and Hsieh (2008): Student presentation

Question for Debate: Does micro data evidence undermine the macro perspective on real exchange rate puzzles?

Part4: Theoretical Models of Pricing to Market

a) Betts and Devereux papers (1996 EER, 2000 JIE)

- Main Idea: Introduce law of one price deviations into an intertmeporal monetary model. Finds that this helps explain the exchange rate data better.

- Model is an extension of Obstfeld and Rogoff, JPE 1995 (OR). It has the same household preferences and budget constraints, government constraint, market clearing …

- But it allows some firms to have prices sticky in the currency of the buyer: 'local currency pricing" (LCP). This literature sometimes calls this "pricing to market" (PTM).

- This is in contrast to OR, where prices sticky in the currency of the producer (producer currency pricing: PCP)

Model Description:

- Two countries, households consume a continuum of differentiated goods and leisure.

- Fraction n of goods are produced by home firms, $1-n$ abroad. Each good is produced by one firm, so has some monopoly power.

- So firms choose price they want. And for fraction s of firms they can choose different prices for home and abroad.

Additional notation needed to deal with the new prices:

p_i Home currency price of home good (in home market)
q_i Foreign currency price of home LCP good (in foreign market)
p_i^* Home currency price of foreign LCP good (in home market)
q_i^* Foreign currency price of foreign non-LCP good (in foreign market)

Implies:
p_i/e Foreign currency price of home non-LCP good (in foreign market)
eq_i^* Home currency price of foreign non-LCP good (in home market)

Note: p or q for currency (home or foreign),
'*' for foreign good

- Like O-R(1995), consumption aggregate is a CES index of differentiated goods, with elasticity theta:

$$C^j = \left[\int_0^1 c^j(z)^{\frac{\theta-1}{\theta}} dz \right]^{\frac{\theta}{\theta-1}}$$

- As in O-R(1995) this will imply a price index and a demand function for good i, where theta is price elasticity of demand:

$$c_i = \left[\frac{p_i}{P} \right]^{-\theta} C$$

Same for foreigners facing price q for the good i

$$c_i*(z) = \left[\frac{q_i}{P} \right]^{-\theta} C*$$

Firm chooses its prices p and q to maximize profit.

- Assume linear production function so cost of producing extra unit of input is W/A, where W is nominal wage and A is technology

- Profit maximization problem for firms under LCP becomes: $\max \ \pi = p_i c_i + e q_i c_i^* - \frac{W}{A}\left(c_i + c^*_i\right)$

- Substitute in demand functions for c_i and c_i*, then take derivatives with respect to p and q.

$$p_i = e q_i = \frac{\theta}{\theta - 1}\frac{W}{A}$$ = markup * marginal cost

Interpret:

- It is assumed that firms must set p and q ahead of time, so the firm is unable to change p and q if a rise in money supply causes e to change.

- This influences how the price index is affected by a change in the exchange rate:

$$P = \left[\int_0^n \overline{p_i}^{1-\theta} di + \int_n^{n+(1-n)s} \overline{p*_i}^{1-\theta} di + \int_{n+(1-n)s}^1 e\overline{q*_i}^{1-\theta} di \right]^{\frac{1}{1-\theta}}$$

(home goods) (LCP part) (non-LCP part)

(share s) (share 1-s)

- The second integral represents the foreign firms setting their prices in the currency of the buyer (LCP).

- The third integral represents foreign firms setting their prices in their own currency.

Basic implications: Under local currency pricing ($s=1$), a rise in the nominal exchange rate (e) will:

1) Have less of an effect on the domestic price level (P). Without LCP, a rise in e affects P by affecting the price that foreign firms charge for their goods. This does not happen if prices are fixed in the currency of the buyer.

2) Have a bigger effect on the real exchange rate (eP^*/P). Without LCP, a rise in e is partly offset by a rise in the domestic price level (P). But as stated above, LCP diminishes this offsetting effect on P.

3) Have no effect on the relative price of home to foreign goods faced by home consumers:

$$\int_0^n \overline{p}_i^{\,1-\theta} di \Big/ \left[\int_n^{n+(1-n)s} \overline{p*}_i^{\,1-\theta} di + \int_{n+(1-n)s}^1 e\overline{q*}_i^{\,1-\theta} di \right]$$

- Without LCP, a rise in the nominal exchange rate makes foreign goods more expensive relative to home goods. But under complete LCP, a change in e has no effect on this relative price.

- These effects are larger for cases where local currency pricing affects more firms (s closer to 1).

Further implication:

- Even more interesting is the implication this has for the equilibrium value of the nominal exchange rate itself. To solve for the equilibrium, use the equilibrium conditions above in log deviations from steady state.

- Money market: Let's begin by looking at the equilibrium in the money market, much as done by Obstfeld and Rogoff (1995) when they solved for their MM curve.

- Set real money supply equal to money demand. Money demand can be viewed here is a simple multiple of consumption, depending on the income elasticity of money demand $(1/\varepsilon)$.

$$\tilde{M} - \tilde{P} = (1/\varepsilon)\tilde{c}$$

Combine this with the foreign country counterpart to get:

$$(\tilde{M} - \tilde{M}^*) = (\tilde{P} - \tilde{P}^*) + (1/\varepsilon)(\tilde{c} - \tilde{c}^*)$$

- Substitute in for prices, using the linearized version of the price index above, where the terms fixed in the short run fall out:

$$\tilde{P} = (1-n)(1-s)\tilde{e}$$

$$\tilde{P}^* = -n(1-s)\tilde{e}$$

to get:

$$(\tilde{M} - \tilde{M}^*) = (1-s)\tilde{e} + (1/\varepsilon)(\tilde{c} - \tilde{c}^*)$$

or:

$$e = \left(\frac{1}{1-s}\right)\left[(\tilde{M} - \tilde{M}^*) - (1/\varepsilon)(\tilde{c} - \tilde{c}^*)\right]$$

- This resembles the monetary approach to exchange rates, where a money supply increase causes the value of the currency to fall.

- We see here already one reason why local currency pricing leads to an amplification of money shocks on the exchange rate: as s rises closer to unity, the first term on the right side of the equal sign grows arbitrarily large.

- This reflects the fact that under local currency pricing, the exchange rate movement has a smaller effect on the price level, as we found above. Price indexes are stickier.

- But note that this is not a full equilibrium. A rise in money supply affects the exchange rate to the degree it increases relative to money demand. And we know from Obstfeld-Rogoff (1995) that a rise in money supply in one country also will lead to a rise in consumption and hence money demand in that country.

- To gauge the effect on consumption, we must look at the goods market equilibrium.

Goods market equilibrium:

- Combining the goods market clearing conditions with the household budget constraints, we derive something very similar to the GG curve of Obstfeld and Rogoff (1995)

$$\tilde{e} = \frac{\tilde{c} - \tilde{c}^*}{(1-s)(\theta-1)+s}$$

- As in Obstfeld-Rogoff, this reflects the expenditure switching in the goods market: a devaluation makes home goods relatively cheaper, shifts demand toward home goods, raises home production, and thus raises home consumption.

- What we see here is that as s rises (for a sufficiently large demand elasticity, theta), this will dampen the rise in relative consumption. This is because local currency pricing dampens the effect of the exchange rate on the relative price of home to foreign goods in each market, as we saw above.

- As a result, local currency pricing tends to dampen the rise in relative consumption and hence money demand, so that the rise in money supply will have a larger effect on the exchange rate.

- Putting the MM and GG curve equations together, we solve for the equilibrium nominal exchange rate:

$$\tilde{e} = \frac{\varepsilon\left(\tilde{M} - \tilde{M}*\right)}{(1-s)(\varepsilon+\theta-1)+s}$$

- So as s rises, shocks to money supply induce a larger volatility in the nominal exchange rate – provided that $\varepsilon + \theta > 2$.

- This condition is satisfied, since we always assume $\theta > 1$ so that the demand is elastic, to permit a sensible equilibrium, and it is typical to assume that the income elasticity of money demand ($1/\varepsilon$) is approximately equal to 1.

Simulations:

- Calibrate key parameter values: markup of price over marginal costs. Use outside estimates of 1.2 for this.

- Consider various values for the share of LCP goods, s. There is some empirical work: share varies by country. Highest is 0.89 for Germany, lowest is 0.45 for U.S.

- Compute variance of nominal exchange rate as ratio of variance of money:

s	Variance ratio
0	0.16
0.45	0.27
0.85	0.57
1.0	1.0

Implications for quantities:

- Recall from our discussion of the consumption correlation puzzle previously that in data: cor(C,C^*) =0.51 , cor(Y,Y^*) = 0.66

- Simulation results of money shocks:

s	*cor(C,C*)*	*cor(Y,Y*)*
0	0.94	-0.97
0.5	0.58	-0.91
0.75	0.28	-0.74
1.0	0.09	0.56

- Results again depend on the share, s, of goods affected by LCP. LCP potentially can easily explain the consumption correlation puzzle.

Explanations:

Consumption levels move together less here than in OR

- As in OR, so also here a rise in home money with no change in price level makes home consumption rise.

- But in OR, the resulting nominal currency depreciation made home exports cheaper and raised foreign consumption. In contrast, LCP prevents any change in relative price of home exports for foreign consumers.

- So there is less rise in C^* abroad. Consumption levels move less together.

Output levels move more closely together than in OR.

- In OR, the rise in demand for home goods in respoese to its cheaper relative price required home firms to produce more of the home good. Demand and production of foreign goods fell.

- But under LCP this expenditure switching does not take place, so outputs move more together.

Questions for Discussion

1) Obstfeld and Rogoff (2000) note that terms of trade are positively correlated with the nominal exchange rate in the data, and argue against sticky price models based on LCP as inconsistent with this fact. Is this correct? Derive the TOT for the Betts-Devereux model.

2) What implications would LCP price stickiness have for the usefulness of monetary policy for output stabilization?

3) How would unexpected exchange rate fluctuations present risks to firms selling abroad that are different under LCP price stickiness than under the PCP case?