Exchange Rate Pass-Through and Market Structure in Multi-Country World

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How should U.S. exporters adjust price when the $ appreciates against the €?

- They can hold the price fixed in seller's currency.
- They can hold the price fixed in buyer's currency.

Why is exporter's pricing decision important?

- Micro reason: It helps us understand dynamics of export price and quantity.
- Macro reason: It affects changes in domestic price of imports. Hence, it influences the inflation rate.

U.S. exporters adjust markup to absorb $ appreciation.

- Buyer's currency price: Exchange rate is a cost shock.

$$p^{€} = p^{\$} e_{€/\$}$$

$$dln(p^{€}) = dln(p^{\$}) + dln(e_{€/\$})$$

- Exchange rate pass-through (ERPT)

$$ERPT = \frac{dln(p^{\$})}{dln(e_{€/\$})}$$

- Given constant marginal cost, ERPT is markup adjustment.

$$dln(p^{€}) = (ERPT + 1) dln(e_{€/\$})$$

(1) When $ERPT = 0$, price is fixed in $.
(2) When $ERPT = -1$, price is fixed in €.

Scale of ERPT

- Empirics

$$ERPT \in [-2.26, 2.55]$$

Feenstra 1989, Knetter 1993, Feenstra and Gagnon 1996, and Campa and Goldberg 2005.

- Theory

$$ERPT \in [-1, 0]$$

  - Lower bound $-1 \rightarrow$ Price is sticky in buyer's currency.
  - Upper bound $0 \rightarrow$ Price is sticky in seller's currency.

Why? Existing studies use two-country models.

Krugman 1986, Dornbusch 1987, Feenstra 1989, Feenstra and Gagnon 1996, Taylor 2000, Devereux, Engel and Storgaard 2004, Bacchetta and van Wincoop 2005, and Atkeson and Burstein 2008.

This study presents a new theory on ERPT.

- Our goals
  1. To extend ERPT outside the [-1,0] range.
  2. To study micro pricing decision.
- Features of the model
  1. Multi-country setup
  2. Quadratic utility (Ottaviano, Tabuchi and Thisse 2002)
     $\rightarrow$ Products are differentiated by location of production.

Value-added of the model

1. The demand curve facing a firm is quasi-linear.
   $\rightarrow$ Own-price elasticity of demand is variable, as shocks on exchange rate change price along the demand curve.
   $\rightarrow$ Shocks on competitors' exchange rates shift the position of the demand curve.
2. We can examine the effect of competitors' pricing behavior on the position of the residual demand.
3. Aggregate price and aggregate demand are analytically tractable.

Notation in multi-country world

- Two-country world

$$p^{€} = p^{\$} e_{€/\$}, \quad ERPT = \frac{dln(p^{\$})}{dln(e_{€/\$})}$$

- Multi-country world

$$p^{d}_{id} = p^{i}_{id} e_{id}, \quad ERPT = \frac{dln(p^{i}_{id})}{dln(e_{id})}$$

Superscript of p: Currency
Subscript of p: Origin and destination
Subscript of e: Destination currency per currency of origin

Consumer's problem

Assume Cobb-Douglas utility at the good level, and quadratic utility at the variety level.

$$u(q_{0d}; q_{id}) = q_{0d} + \alpha \sum_i q_{id} - \frac{\beta}{2} \sum_i (q_{id})^2 - \gamma \sum_{j \neq i} \sum_i q_{id} q_{jd},$$

$\alpha > 0$, $\beta \geq \gamma > 0$.
β: Love-of-variety parameter
γ: Degree of substitution across varieties
q_{0d}: Consumer's demand in country d for numeraire
q_{id}: Consumer's demand in country d for export from country i

Demand curve

- Budget constraint

$$\sum_i p_{id}^d q_{id} + q_{od} = w_d l_d + y_d,$$

w_d: Wage; l_d: Labor supply; y_d: Numeraire endowment

- First-order condition

$$\alpha - \beta q_{id} - \gamma \sum_{j \neq i} q_{jd} = p_{id}^d$$

- Residual demand

$$q_{id} = \frac{\alpha(\beta - \gamma) + \gamma \sum_{j \neq i} p_{jd}^d}{(\beta - \gamma)(\beta + \gamma(N-1))} - \frac{\beta - \gamma + \gamma(N-1)}{(\beta - \gamma)(\beta + \gamma(N-1))} p_{id}^d$$

N: World total number of exporters

Residual demand and market structure

N_i: Number of symmetric exporters in country i

$$q_{id} = \frac{\alpha(\beta-\gamma)+\gamma\sum_{j\neq i} N_j p_{jd}^d}{(\beta-\gamma)(\beta+\gamma(N-1))} - \frac{\beta+\gamma(N-N_i-1)}{(\beta-\gamma)(\beta+\gamma(N-1))} p_{id}^d \quad (1)$$

Price elasticities of demand

- Own-price elasticity of demand

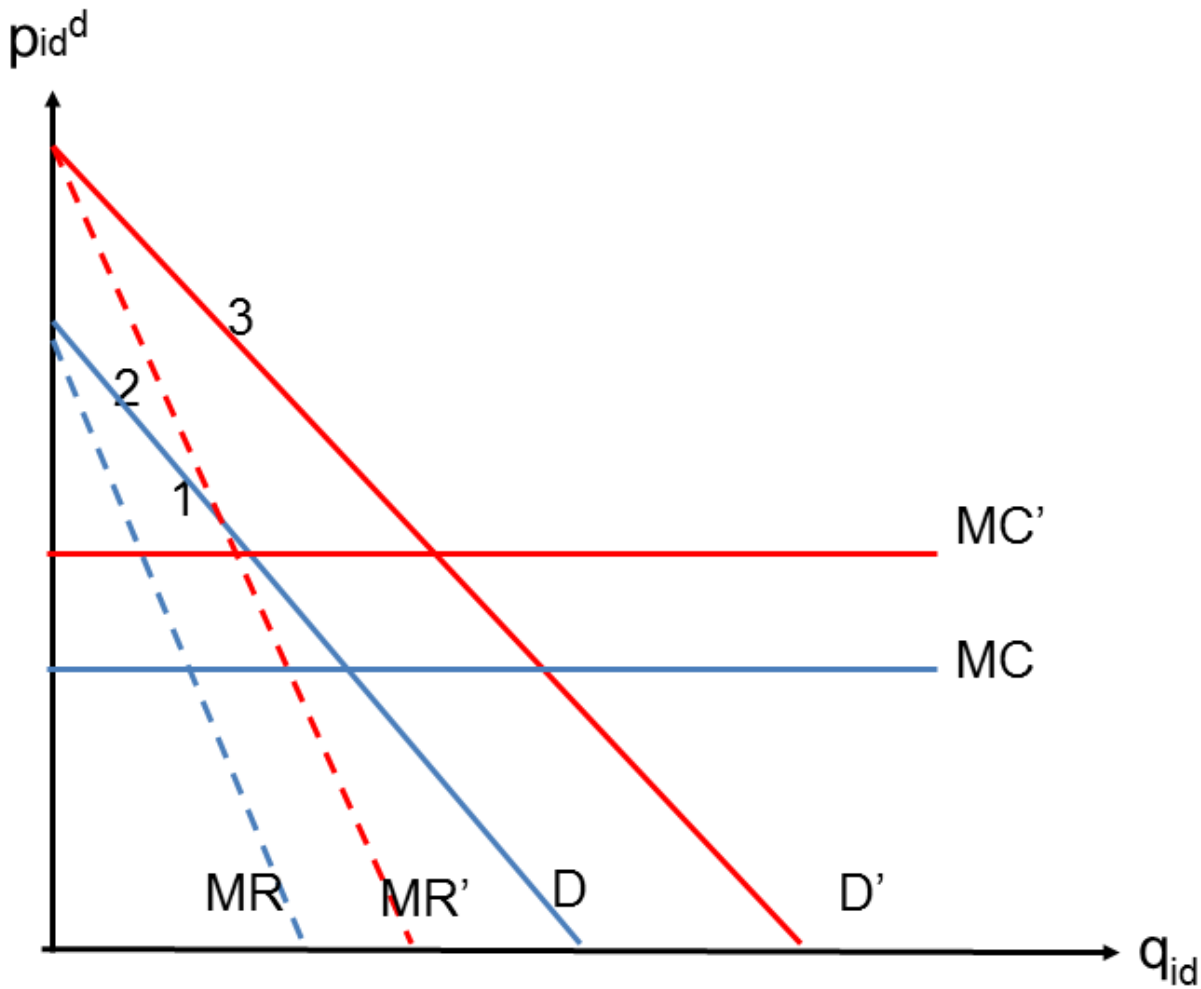
$$\theta_{id} = -\frac{\partial q_{id}}{\partial p^d_{id}} \frac{p^d_{id}}{q_{id}} = \left[\frac{\beta + \gamma(N - N_i - 1)}{(\beta - \gamma)(\beta + \gamma(N-1))} \right] \frac{p^d_{id}}{q_{id}} \tag{2}$$

- Cross-price elasticity of demand

$$\theta_{ijd} = \frac{\partial q_{id}}{\partial p^d_{jd}} \frac{p^d_{jd}}{q_{id}} = \frac{\gamma N_j p^d_{jd}}{(\beta - \gamma)(\beta + \gamma(N-1)) q_{id}} \tag{3}$$

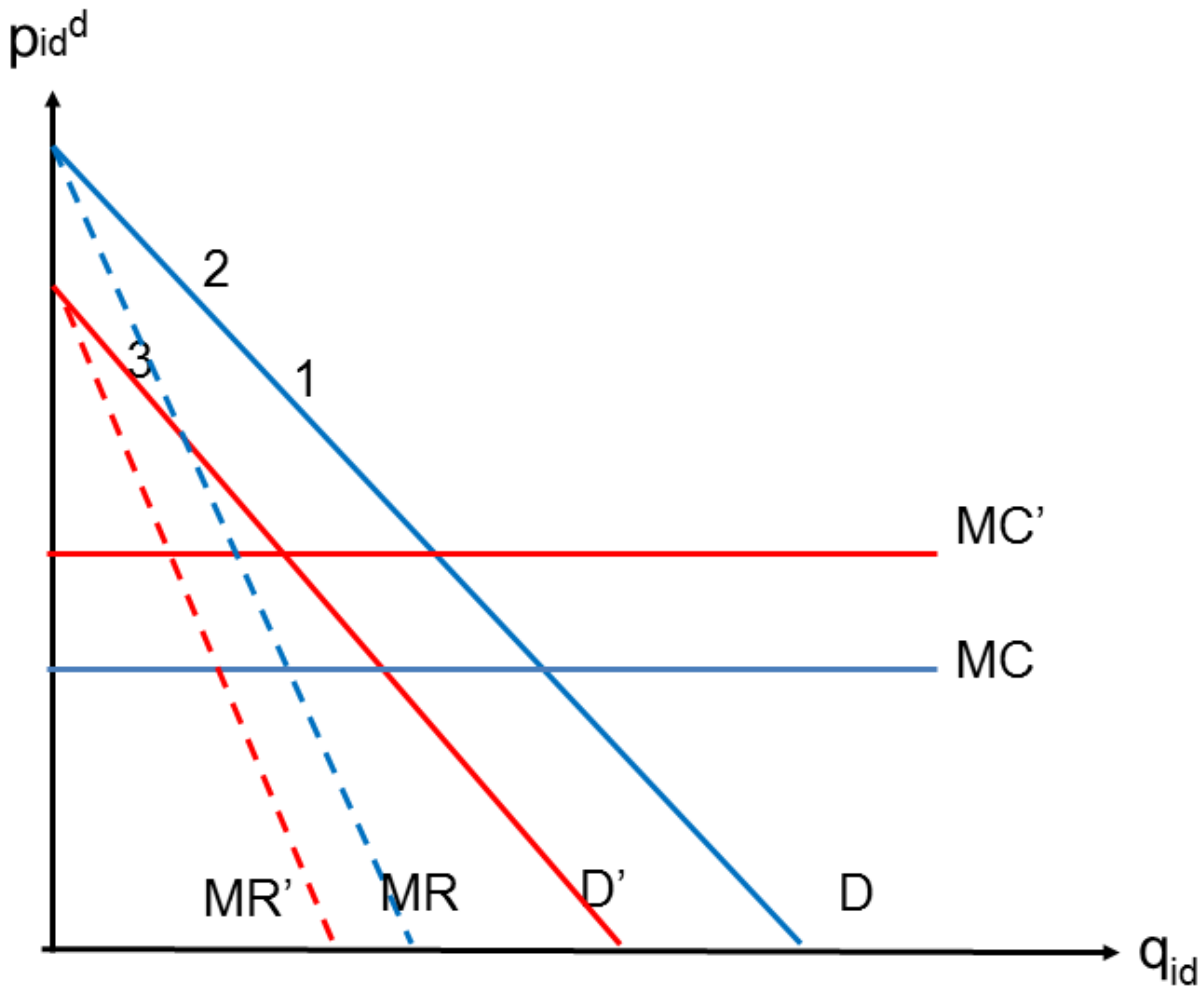
Effect of appreciation of the competitor's currency

Cross-price effect raises the optimal price.



Effect of depreciation of the competitor's currency

Cross-price effect reduces the optimal price.



Export price is driven by shocks on all exchange rates.

$$dln(p^i_{id}) = \epsilon_{ii} dln(e_{id}) + \sum_{j \neq i} \epsilon_{ij} dln(e_{jd}) \tag{4}$$

- Own ERPT

$$\epsilon_{ii} = -0.5 \left(\frac{\theta_{id} + 1}{\theta_{id}} \right) \tag{5}$$

- Cross ERPT

$$\epsilon_{ij} = 0.5 \frac{\theta_{ijd}}{\theta_{id}} \left(\frac{\theta_{jd} - 1}{\theta_{jd}} \right) \tag{6}$$

Own ERPT is between -1 and -0.5.

Proposition 1
Suppose $1 < \theta_{id} < \infty$. Then $\epsilon_{ii} \in (-1, -0.5)$.

Proof.
From (5), $d\epsilon_{ii}/d\theta_{id} > 0$, so ϵ_{ii} is monotonically increasing in θ_{id}.
When $\theta_{id} = 1$, $\epsilon_{ii} = -1$. Also, $\lim_{\theta_{id} \to \infty} \epsilon_{ii} = -0.5$. □

Own ERPT is increasing in the own-price elasticity of demand, when the own-price elasticity is greater than one.

Proposition 2
Suppose $1 < \theta_{id} < \infty$. Then $d\epsilon_{ii}/d\theta_{id} > 0$.

Proof.
From (5), $d\epsilon_{ii}/d\theta_{id} = 0.5/(\theta_{id})^2 > 0$ □

Own ERPT is increasing in the number of world exporters.

Proposition 3
$d\epsilon_{ii}/dN > 0$.

Proof.
$d\epsilon_{ii}/dN = (d\epsilon_{ii}/d\theta_{id})\, d\theta_{id}/dN$. From the equilibrium own-price elasticty in (2), $d\theta_{id}/dN > 0$. From Proposition 2, $d\epsilon_{ii}/d\theta_{id} > 0$. □

Cross ERPT is positive when the own-price elasticity of competing exporters is greater than one.

Proposition 4

Suppose $\theta_{jd} > 1$. Then $\epsilon_{ij} > 0$.

Proof.

When $\theta_{jd} > 1$, $\theta_{jd} - 1 > 0$. According to (6), $\epsilon_{ij} > 0$. □

Cross ERPT and bias in ERPT estimate

When exchange rates comove, $dln(e_{jd}) = \eta_{ji} dln(e_{id})$, $\eta_{ji} \neq 0$.

$$dln(p^i_{id}) = \epsilon_{ii} + \sum_{j \neq i} \eta_{ji} \epsilon_{ij}) dln(e_{id}) \tag{7}$$

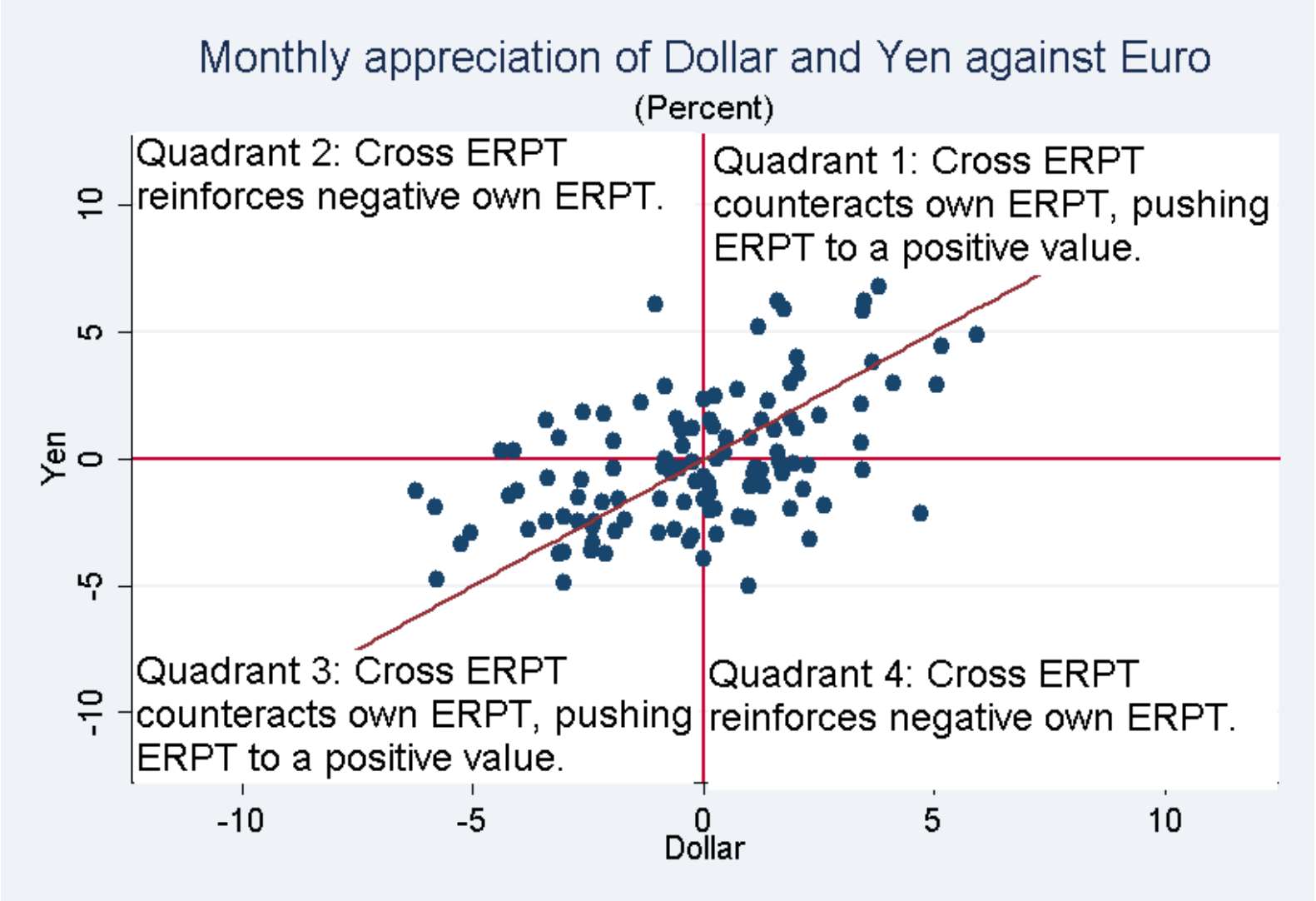
$$\epsilon_i = \epsilon_{ii} + \sum_{j \neq i} \eta_{ji} \epsilon_{ij} \tag{8}$$

- The EPRT estimate in the empirical literature is a biased estimate of own ERPT, because the regression omits competitors' exchange rates.
- The size of bias is increasing in the comovement η_{ji} and the cross-price elasticity θ_{ijd}.

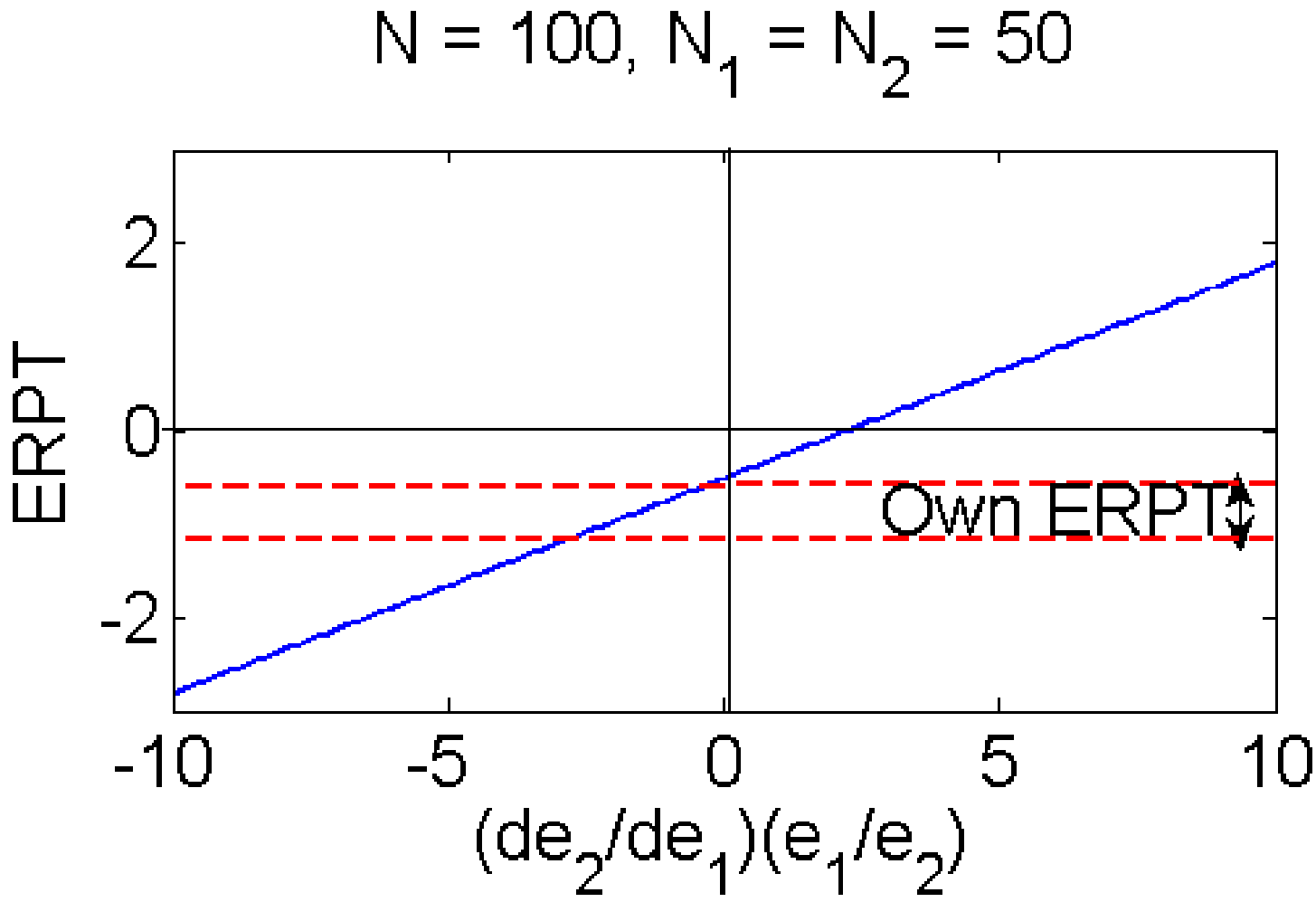
Other implications of cross ERPT

1. There is ERPT within a currency union. Cross ERPT implies that (French) exporters adjust price of goods sold to union members (Germany, Italy, etc.) in response to shocks on exchange rates outside the union ($/€ exchange rate).
2. Changes in exchange rate regimes create structural changes in ERPT.
3. Changes in locations of competing exporters create structural changes in ERPT.
4. Currently there are no estimates of cross-price elasticity in the trade literature. This model suggests we use exchange rate shocks to identify cross-price effects on trade.

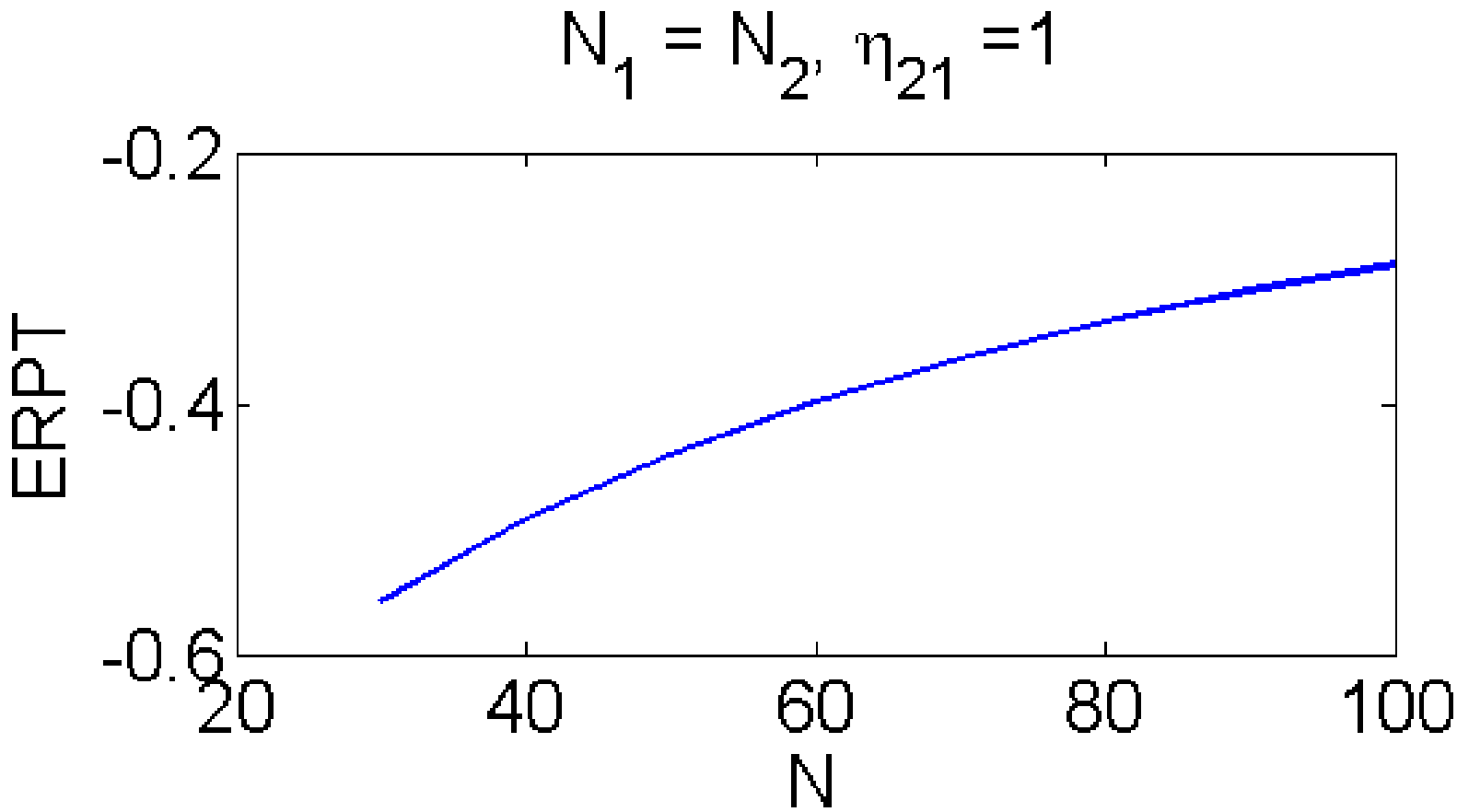
How large are comovements of exchange rates?



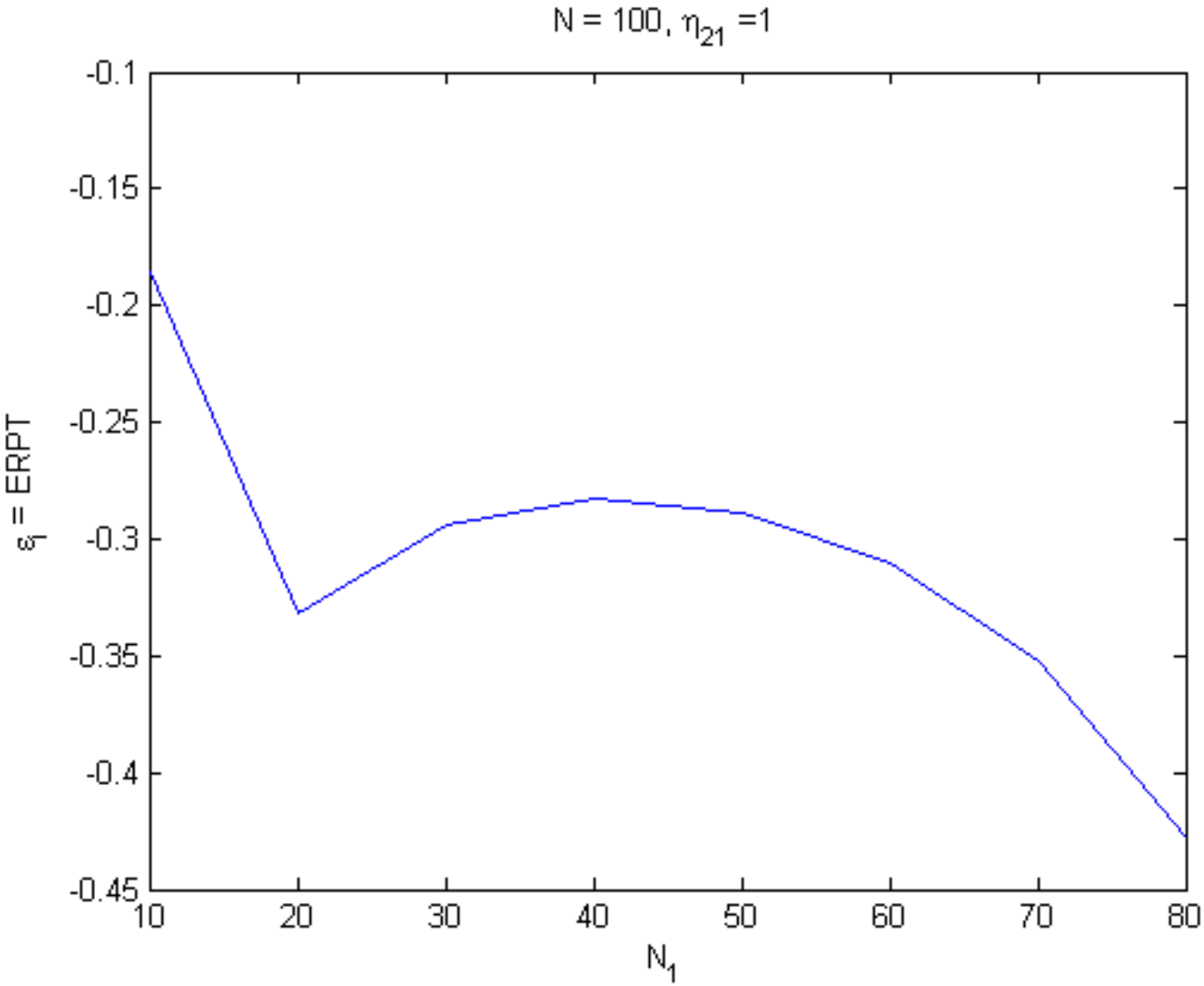
Simulated ERPT



Simulated ERPT and the number of world exporters



Simulated ERPT and the number of own exporters



Note:

Exchange rate elasticity $\eta_{21} = 1$. Number of world exporters: $N = 100$.

Summary

The proposed model produces the following new results.

1. Wide range of ERPT, as in the empirical literature.
2. To get an unbiased ERPT estimate, the estimating equation must include competitors' exchange rates.
3. There is ERPT within a currency union.
4. Changes in exchange rate regimes and locations of competing exporters result in structural changes in ERPT.
5. We can use shocks on competitors' exchange rate to identify cross-price effects on trade.