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LECTURE NOTES ON
INTERNATIONAL FINANCE

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Part I

Non-neutrality of Nominal Exchange Rate

1 Non-neutrality of Nominal Exchange Rate

1.1 Definitions

Definition (NER). The *nominal exchange rate* $E_{in,t}$ is the price of country i 's currency in terms of country n 's currency.

Definition (RER). The *real exchange rate* $RER_{in,t}$ is the price of country i 's consumption basket in terms of country n 's consumption basket. Effectively, this means:

$$RER_{in,t} = \frac{P_i}{P_n} \cdot E_{in,t}$$

Remark:

1. This definition can be traced back to ¹.
2. The behavior of RER over time depends much on what **prices** are used to calculate RER. Common choices are CPI (consumer price index), PPI (producer price index), and IPI (import, or also called border prices).
3. We can also rewrite the definition in log form:

$$rer_{in,t} = p_i - p_n + e_{in,t}$$

The concept of **neutrality of nominal exchange rate** is the idea that fluctuations in relative national price ratio ($p_i - p_n$) will be fully compensated for by fluctuations in the NER, leaving the RER unchanged. For example, higher inflation in country i should be accompanied by a depreciation of the NER to allow for the real relative price of consumption baskets between the two countries unchanged. This is also called the **relative purchasing power parity** (relative PPP) hypothesis:

Definition (Relative PPP hypothesis). The RER is constant between any country-pair.

However, [?] found serious deviation from PPP, and in fact the RER fluctuates a lot with long half-lives,² which suggests **non-neutrality of NER**.

Finally, for the next section, we need to define exchange rate pass-through (ERPT), a concept that talks about sensitivity of price to movements of the nominal exchange rate:

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² Her actual finding was that the RER of country with fixed exchange rate fluctuates much less compared to RER of country with floating exchange rate.

Definition (ERPT). *The exchange rate pass-through (ERPT) is a measure of how responsive international prices are to changes in exchange rates.*

ERPT is estimated using the following dynamic lags regression:

$$\Delta p_{in,t} = \alpha_{in} + \sum_{k=0}^T \beta_{in,k} \Delta e_{in,t-k} + \gamma_{in} X_{in,t} + \epsilon_{in,t}$$

where $X_{in,t}$ is a vector of controls. Setting $T = 0$ measures the short-run pass-through, while $T = 8$ measures the long-run pass-through.

1.2 Empirical facts about NER and ERPT

Here are some stylized facts about NER and RER (from ³):

Stylized Fact 1.2.1 (Deviation from PPP). *CPI RER co-moves closely with NER at short- and medium-horizons. The persistence of these RERs is large with long half-lives.*

The regression ran is

$$\Delta rer_{in,t}^{cpi} = \Delta e_{in,t}^{cpi} + \Delta cpi_{i,t} - \Delta cpi_{n,t}$$

Numbers to remember: correlation between Δrer and Δe is near 1 for most countries. Half-lives are between 3-6 years (with some longer).

Stylized Fact 1.2.2 (RER for tradable goods). *Movements in the RER for tradable goods are roughly as large as overall CPI RER when calculated using CPI or PPI, but much smaller when using border prices.*

The correlation between Δrer_{tr}^{cpi} and Δrer^{cpi} are close to 1, but this correlation is only 0.3 when using border prices. That is, relative prices at the consumer level co-move more closely with the NER and are more volatile than when using border prices.

Stylized Fact 1.2.3 (ERPT). *ERPT into consumer prices is lower than into border prices. ERPT into border prices is typically incomplete.*

Stylized Fact 1.2.4. *Border prices, in whatever currency they are set in, respond partially to exchange rate shocks at most horizons, even when conditional on a price change.⁴*

Stylized Fact 1.2.5 (International Price System). *A large fraction of exports/imports around the world nowadays are priced in dollar (even when the US is not involved in the trade). Countries with higher share of imports invoiced in a foreign currency have higher short-run and long-run pass through.*

Think about three countries: US, Japan, and Turkey. The US and Japan are developed markets, while Turkey is an emerging market. ERPT into import prices for the US is about .3, while it is above .8 for Japan and Turkey.

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⁴ 'Respond partially' here means that the elasticity is less than 1. 'Conditional on a price change' means we limit our sample to only goods that have had a price change. We do so out of the concern that the results might have been biased down to goods that never change prices at all.

To explain this, note that the US have most of imports/exports priced in dollar, while Japan and Turkey have a large share of imports priced in a foreign currency (here, the dollar). Price of goods in the currency of invoicing (i.e. the dollar) is very **insensitive** to movements in the nominal exchange rates, hence the pass-through into import prices in local currencies in Japan and Turkey is very high in both short- and long-run. See ⁵ for a discussion of the International Price System.

1.3 ERPT and the incompleteness of ERPT into border prices

We start with some reduce-form specifications:

$$p_{in} = \mu_{in} + mc_{in} \quad (1.1)$$

$$\mu_{in} = \mu_{in}(p_{in} - p_n) \quad (1.2)$$

$$mc_{in} = mc_{in}(q_{in}, w_i, e_{in}) \quad (1.3)$$

This says that the price of a good imported from country i into country n (expressed in country n 's currency), p_{in} , is a markup $exp(\mu_{in})$ over marginal cost $exp(mc_{in})$.⁶ The markup then is a function on the relative price ratio between the import price and the general price index in country n . Intuitively, if the imported price is too high compared to the general price level in country n , markup cannot be too high. The marginal cost of production in country i depends on the quantity of exports q_{in} , factor price of production (here is labor) in country i (here is wage w_i), and the nominal exchange rate between the two countries, since this marginal cost is **expressed in local currency** of country n .

⁶ Every variable is expressed in log forms.

Log-differentiating (1.1) gives us

$$\Delta p_{in} = -\Gamma_{in} \cdot (\Delta p_{in} - \Delta p_n) + mc_q \cdot \Delta q_{in} + w_{in} + \alpha_{in} \cdot \Delta e_{in}$$

$$\Delta q_{in} = -\epsilon_{in}(\Delta p_{in} - \Delta p_n) + \Delta q_n$$

where:

$$\Gamma_{in} \equiv \frac{-\partial \mu_{in}}{p_{in} - p_n} : \text{Elasticity of markup to relative price}$$

$$mc_q \equiv \frac{\partial mc_{in}}{\partial q_{in}} : \text{Sensitivity of marginal cost on quantity imported}$$

$$\alpha_{in} \equiv \frac{\partial mc_{in}}{\partial e_{in}} : \text{Sensitivity of marginal cost (in destination's currency) to NER}$$

Denote $\Phi_{in} = mc_q \epsilon_{in}$ as the total effects coming from decreasing returns to scale. Re-arranging gives us a formula for ERPT:

$$ERPT \equiv \frac{\Delta p_{in}}{\Delta e_{in}} = \underbrace{\frac{\alpha_{in}}{1 + \Gamma_{in} + \Phi_{in}}}_{\text{Direct ERPT}} + \frac{\Gamma_{in} + \Phi_{in}}{1 + \Gamma_{in} + \Phi_{in}} \frac{\Delta p_n}{\Delta e_{in}} + \frac{mc_q}{1 + \Gamma_{in} + \Phi_{in}} \frac{\Delta q_n}{\Delta e_{in}}$$

The **direct ERPT** is defined as the ERPT when $\Delta p_n = \Delta q_n = \Delta w_i = 0$, that is when there is no change in the general price or quantity level in the sector of imported goods, nor wage in the exporting country. This allows us to isolate the sole effect of exchange rate on domestic price of destination country. *Regression effectively estimates overall ERPT without appropriate controls.*

It is important to remember the formula for direct ERPT:

$$\frac{\Delta p_{in}}{\Delta e_{in}} = \frac{\alpha_{in}}{1 + \Gamma_{in} + \Phi_{in}} \quad (1.4)$$

To try to understand incompleteness of ERPT into border prices, we can try to look at:⁷

- (1) Γ_{in} : How sensitive is markup charged by foreign firms to exchange rate? The more sensitive markups are, the lower ERPT.

We will find in the models presented in this section that more productive firms (firms with low relative price in the **non-CES demand** models, firms with higher market share in the **pricing-to-market** models, and firms with high distribution share in **distribution cost** models) have **high elasticity of markup**, hence very low ERPT.

- (2) α_{in} : How sensitive is exporter's costs to exchange rate?

- (3) Φ_{in} : The role of decreasing returns to scale ($\Delta e_{in} \rightarrow \Delta q_{in} \rightarrow \Delta mc_{in}$). Intuitively, a nominal depreciation of country n 's currency makes imports into n more expensive, this forces exporters in i to cut back production. With decreasing returns to scale, this lowers average (and possibly marginal) cost, making the goods cheaper, working against the effect of a nominal depreciation. Therefore, the higher Φ_{in} , the lower ERPT.

⁷The literature focuses on the effect of α and Γ . DRS effect (Φ) is completely underplayed.

1.3.1 Effects of nominal rigidities on ERPT

Note that our analysis in the previous section assumed **flexible pricing** by producers. Hence, the formula for direct ERPT given by (1.4) implicitly assumes that p_{in} is flexible, and producers in i can change this price to respond to fluctuations in the exchange rate all the time. It is worth noticing that the **currency of invoicing** is completely irrelevant for flexible price models (because every period can reset price to factor in movements of exchange rates as desired). However, under sticky prices, optimal **endogenous currency choice** to minimize currency risk during periods of unable to change price **matters** (see [?]).

Now we consider an environment in which there is **Calvo pricing** for producers in i . In particular, every period, only a fraction $(1 - \kappa)$ of firms can change its price ($\kappa = 0$ is equivalent to flexible price). We also assume

constant returns to scale to isolate the effects coming from decreasing returns to scale ($\Phi_{in} = 0$).

Denote $\tilde{p}_{in,t}$ the log desired price (price that firms would set had prices been flexible):

$$\tilde{p}_{in,t} = \arg \max_{p_{in}} \Pi(p_{in}|s_t) \quad (1.5)$$

Ignore currency choice for now and assume LCP (local currency pricing). The FOC for the reset price $\bar{p}_{in,t}$ is simply the derivative of the fraction of discounted stream of profits in every period in the future that would prevail had firms not been able to change the price at all:⁸

$$\sum_{l=0}^{\infty} \kappa^l \mathbb{E}_t \Theta_{t+l} \Pi_p(\bar{p}_{in,t}|s_{t+l}) = 0 \quad (1.6)$$

We first-order approximate marginal profit state-by-state around the desired-price in that state:

$$\Pi_p(\bar{p}_{in,t}|s_{t+l}) = \tilde{\Pi}_{pp}(t+l)[\bar{p}_{in,t} - \tilde{p}_{in,t+l}] + \mathcal{O}(\bar{p}_{in,t} - \tilde{p}_{in,t+l})^2 \quad (1.7)$$

where $\tilde{\Pi}_{pp}(t) \equiv \Pi_{pp}(\tilde{p}_{in,t}|s_t)$.

Note that we have used the fact that $\Pi_p(\tilde{p}_{in,t+l}|s_{t+l}) = 0$ due to optimality of reset price. Assume continuity of Π_p , we can approximate $\Pi_{pp}(\tilde{p}_{in,t+l}|s_{t+l})$:

$$\Pi_{pp}(t+l) = \Pi_{pp}(t) + \mathcal{O}(\|s_{t+l} - s_t\|)$$

See ⁹ for a complete proof. Re-arranging and ignore high order terms gives us the approximation for optimal reset price (in terms of desired prices):

$$\bar{p}_{in,t} = (1 - \beta\kappa) \sum_{l=0}^{\infty} (\beta\kappa)^l \mathbb{E}_t \tilde{p}_{in,t+l} \quad (1.8)$$

Desired price, up to first-order approximation is

$$\tilde{p}_{in,t+l} = \frac{1}{1 + \Gamma_{in}} [w_{i,t+l} + \alpha_{in} e_{in,t+l} + \Gamma_{in} p_{n,t+l} + const_{in}]$$

Substitute into (1.8) to find that

$$\bar{p}_{in,t} - \bar{p}_{in,t-j} = (1 - \beta\kappa) \frac{\alpha_{in}}{1 + \Gamma_{in}} \left[\mathbb{E}_t \sum_{l=0}^{\infty} (\beta\kappa)^l e_{in,t+l} - \mathbb{E}_{t-j} \sum_{l=0}^{\infty} (\beta\kappa)^l e_{in,t-j+l} \right] \quad (1.9)$$

Assume an AR(1) process for e_t with persistence ρ_e : $\mathbb{E}_t e_{t+l} = \rho_e^l e_t$, we get the ERPT **conditional on a price change**:

$$\bar{p}_{in,t} - \bar{p}_{in,t-j} = \frac{1 - \beta\kappa}{1 - \beta\kappa\rho_e} \frac{\alpha_{in}}{1 + \Gamma_{in}} (e_{in,t} - e_{in,t-j})$$

That is, prices move proportionally with changes in exchange rates. We can calculate the **new direct ERPT with price rigidity and AR(1) NER**:

$$\frac{\Delta p_{in,t}}{\Delta c e_{in,t}} = \frac{1 - \beta\kappa}{1 - \beta\kappa\rho_e} \frac{\alpha_{in}}{1 + \Gamma_{in}} \quad (1.10)$$

⁸ Note that the remaining part of the objective function when firms are allowed to change price again is orthogonal to this problem, hence derivative of that part would be zero.

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Some remarks: When $\kappa = 0$ (flexible prices), we get back to the pass-through formula that we had before. When ρ_e increases, ERPT is higher. This is also intuitive, as a more persistent NER process would imply there is more effect of a ER shock to prices *in periods that firms cannot change their prices*. Note that this channel is complete shut off if we have flexible prices. Finally, if $\rho_e = 1$, i.e. NER follows a random walk, then we are also back into the flexible prices world (Why? My guess is that a random walk gives the firm zero information, so there is no role for strategic pricing).

Things to remember from this section:

- (1) Nominal rigidity changes pass-through because firms price strategically (effectively, choosing 'desired pass through') to maximize their profit during periods they cannot change prices.
- (2) If the NER is a random walk, then nominal rigidity does not matter, and the ERPT in this case is the same as flexible price pass-through.

1.3.2 Endogenous currency choice

As shown in [?] using a formal model with Calvo-pricing, and firms choose to price in the local (n) currency as opposed to the producer (i) currency, firms choose to price in the local currency if

$$\frac{\text{Cov}_{t-1}(\tilde{p}_{in,t}^n, e_{in,t})}{\text{Var}_{t-1}(e_{in,t})} < \frac{1}{2}$$

and price in the producer currency otherwise.

This is easy to see. Note that the fraction on the left of the inequality is the coefficient $\hat{\beta}$ when regressing desired reset price against the nominal exchange rate, which can be interpreted as the 'desired pass through.' So if the desired pass through is less than $1/2$, it is better for firm to invoice in local currency (i.e. pass through is 0%; and if desired pass through is more than $1/2$, it is better to set price in producer currency, which gives pass through of 100%.

Note, the authors used first-order approximation, which eliminated all hedging motives in the second-order.

Part II

Exchange Rate Determination

2 *Introduction*

3 *Monetary Models for ER Determination*

4 *Risk Models for ER Determination*

5 *Portfolio Balance Models for ER Determination*

Part III

Monetary and Exchange Rate Policy

6 *A Basic Open Economy New Keynesian Model*

7 *Does Exchange Rate Regime Matter?*

8 *Fiscal Devaluation, Fiscal Union*

Part IV

International Capital Flows

9 Introduction and Empirical Facts

CAPITAL FLOWS is a topic of interest in international finance, since an open economy is all about the exchange of resources and financial assets across borders.

In this chapter, empirical facts will be presented to confront the predictions of standard macro-models, showing that many empirical regularities in the data is at odds with conventional wisdom on consumption-smoothing, risk-sharing, and efficient investment.

In subsequent chapters, we will examine how we alter models to fit the evidence on global capital flows, with key focus on *direction of flows* and *magnitude*. Then, we will examine how increasing cross-border financial integration affects the external adjustment process.

10 Portfolio Bias

10.1 Cole and Obstfeld (1982)

This paper examines the benefits of financial market in consumption risk-sharing, and points out that welfare gains might be quite small. This explains some of the standing puzzle in international economics - the extremely high home bias and the Feldstein-Horioka (1980) puzzle. The answer is that because welfare gains from risk-sharing is very low (they found to be 0.2% annual GDP), even with minor trade impediment, this welfare gains can be wiped out.

10.1.1 The model

- Two countries: home (H) and foreign (F). Distinct national outputs X and Y .¹
- Utility $u(C) = C^{1-\sigma}/(1-\sigma)$, where $C \equiv x^\theta y^{1-\theta}$.
- Each country maximizes $\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t u(C)$, full set of Arrow-Debreu securities, market clearing $x + x^* = X, y + y^* = Y$.

¹ Follow Lucas (1982)

10.1.2 Equilibrium

Optimization: Complete market implies Backus-Smith condition

$$u'(C)/u'(C^*) = k \cdot P/P^* = k$$

$$\Rightarrow \frac{C}{C^*} = k^{-1/\sigma}$$

Intra-temporal choice of X versus Y in the case of Cobb-Douglas gives

$$\frac{x}{y} = \frac{x^*}{y^*} = \frac{\theta p_y}{(1-\theta)p_x}$$

Now, consider portfolio autarky, i.e. countries cannot smooth out consumption across time and states of nature anymore. However, there can still be balanced trade:

$$PC = p_x x + p_y y = p_x X, \quad PC^* = p_x x^* + p_y y^* = p_y Y$$

This implies that

$$\frac{PC}{PC^*} = \frac{C}{C^*} = \frac{p_x X}{p_y Y} = \frac{\theta}{1-\theta} \frac{y X}{x Y} = \frac{\theta}{1-\theta} \frac{\omega Y X}{\omega X Y}$$

So:

$$\frac{C}{C^*} = \frac{\theta}{1-\theta}$$

and the financial autarky is Pareto efficient!

In this case, even with complete absence of the financial market, each country's level of consumption remains efficient, and there is zero gains from financial liberalization.