316-632 INTERNATIONAL MONETARY ECONOMICS NOTE 8a

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It's time now to turn our attention to Obstfeld and Rogoff's paper "The Six Major Puzzles in International Macroeconomics: Is There a Common Cause?" The six puzzles of the title are:

1. The home bias in international trade puzzle: why are international goods markets so segmented?
2. The Feldstein-Horioka puzzle: why are savings and investment rates so positively correlated in OECD countries? (i.e., why is international capital mobility between industrialist countries so limited?)
3. The home bias in equity portfolios puzzle: why don't stockholders avoid unnecessary exposure to idiosyncratic, home-country-specific risks?
4. The international consumption correlations puzzle: why is the correlation of consumption growth between pairs of industrial countries so **low**? If citizens completely share risks, consumption growth correlations should be near one.
5. The purchasing power parity puzzle: why do shocks to real exchange rates take so long to dissipate?
6. The exchange rate disconnect puzzle: why are exchange rate movements so volatile and so seemingly disconnected from movements in economic fundamentals?

The common cause that Obstfeld and Rogoff (OR) focus on is **trade costs** — transportation costs, tariffs etc — that act as a friction in international **goods markets**. In particular, they emphasize that international goods markets are much more frictional than international asset markets.

Home bias in trade puzzle

We begin by discussing what the issue is and then turn to OR's answer.

A. The issue

International goods markets are highly **segmented**. Even when we control for factors like the economic size of trading partners and the distance between them, trade between regions within a given country is much greater than trade between regions in different countries. Borders matter.

Studies like McCallum (1995, AER) run regressions of the form

$$\log(\text{shipments}_{ij}) = \alpha_1 \log(\text{GDP}_i) + \alpha_2 \log(\text{GDP}_j) + \alpha_3(\text{distance}_{ij}) + \beta(\text{dummy}_{ij}) + \text{error}_{ij}$$

where shipments$_{ij}$ = shipments of goods from region i to j, distance$_{ij}$ is the actual distance between the principal cities of regions i and j and dummy$_{ij}$ = 1 if the trade is between regions in the same country and = 0 if the trade is between regions in two different countries. McCallum studies regressions of this form for data on Canadian provinces and US states. Typical regression estimates are $\alpha_1 = 1.2$, $\alpha_2 = 1.1$, $\alpha_3 = -1.4$ and $\beta = 3.1$. Other things equal, bigger trading partners increase the value of bilateral shipments between them and bigger distance reduces the value of shipments between them. But a coefficient of $\beta = 3$ suggests that the level of shipments between regions in the same country are about 20 (= exp(3)) times larger than is the level of shipments between regions in different countries! And this even when we control for factors like distance and market size.

It is common to refer to estimates of $\exp(\beta)$ as a measure of **home bias**. Although other studies suggest a smaller bias and bring down estimates of $\exp(\beta)$ to something between 2.5 and 12, these still seem like big numbers.

One possible explanation is that trade costs really are big, so we should expect big border effects. However, there are no language barriers between the US and Canada and measured tariff barriers and transportation costs seem too small to account for a big border effect. Another possibility is that consumers have a preference for home goods. This seems like an unattractive argument: it seems too "convenient" to be the main reason for a **big** border effect.

Obstfeld and Rogoff argue, however, that one can account for a big home bias with moderate trade costs once the elasticity of substitution across home and foreign goods is taken into account. There is an important interaction between the elasticity of substitution across goods and trade costs and that this interaction means that actual trade costs may not need to be particularly high.

B. Obstfeld and Rogoff's answer

OR consider a static endowment economy. There are two countries and in each country a representative consumer. The consumer in the home country has utility function

$$C = \left[C_H^{\frac{\theta-1}{\theta}} + C_F^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}, \qquad \theta > 0$$

and similarly, the consumer in the home country has utility

$$C^* = \left[C_H^{*\frac{\theta-1}{\theta}} + C_F^{*\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}, \qquad \theta > 0$$

The parameter $\theta > 0$ is the **elasticity of substitution** between C_H and C_F. When $\theta \to \infty$ the two goods are **perfect substitutes**, when $\theta \to 0$ the two goods are **perfect complements**, and when $\theta \to 1$ the utility function is Cobb-Douglas. Notice that there is no home bias in preferences. The potential for home bias will emerge from an interaction between trade costs and the elasticity of substitution.

The home consumer is endowed with Y_H units of the home good while the foreign consumer is endowed with Y_F units of the foreign good. The budget constraints in each country are

$$\begin{aligned} P_H C_H + P_F C_F &\leq P_H Y_H \\ P_H^* C_H^* + P_F^* C_F^* &\leq P_F Y_F \end{aligned}$$

Obstfeld and Rogoff consider **iceberg** transportation costs of shipping goods between the two countries. Specifically, if 1 unit of the home good is shipped from home to foreign, only $1-\tau$ units of the good arrive in the foreign country. No-arbitrage in the market for the home country's good then dictates that the prices of the home good in the home and foreign country are linked by

$$P_H = (1-\tau)P_H^*$$

Similarly, if 1 unit of the foreign good is shipped to the home country, only $1-\tau$ units arrive in the home country. So no-arbitrage in the market for foreign goods implies that the prices of the foreign good satisfy

$$(1-\tau)P_F = P_F^*$$

If we let the home country's good be the numeraire in each country, we can define the relative prices

$$p \equiv \frac{P_F}{P_H}, \qquad p^* \equiv \frac{P_F^*}{P_H^*}$$

The goods market no-arbitrage conditions then imply

$$p = \frac{1}{(1-\tau)^2} p^* \tag{1}$$

The optimization problem for a consumer in the home country is solved with the aid of the

Lagrangian

$$\mathcal{L} = \left[C_H^{\frac{\theta-1}{\theta}} + C_F^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}} + \lambda \left[Y_H - C_H - pC_F \right]$$

where $\lambda \geq 0$ is a Lagrange multiplier. The interesting first order conditions are

$$\begin{aligned} \left[C_H^{\frac{\theta-1}{\theta}} + C_F^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}-1} C_H^{\frac{\theta-1}{\theta}-1} &= \lambda \\ \left[C_H^{\frac{\theta-1}{\theta}} + C_F^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}-1} C_F^{\frac{\theta-1}{\theta}-1} &= \lambda p \end{aligned}$$

which implies

$$\frac{C_H}{C_F} = p^{\theta} \tag{2}$$

Notice that this first order condition implies the elasticity

$$\frac{d \log \left(\frac{C_F}{C_H} \right)}{d \log(p)} = -\theta$$

so that if the relative price of the foreign good increases by 1%, the relative demand for the foreign good falls by $-\theta\%$. This justifies the name given to the parameter θ.

Similarly for foreign country

$$\frac{C_H^*}{C_F^*} = p^{*\theta} \tag{3}$$

We can solve for the level of consumption by combining the first order conditions with the budget constraint. We have for the home country

$$\begin{aligned} C_H + pC_F &= Y_H \\ C_H &= p^{\theta} C_F \end{aligned}$$

which gives solutions

$$\begin{aligned} C_H &= \frac{p^{\theta}}{p + p^{\theta}} Y_H \\ C_F &= \frac{1}{p + p^{\theta}} Y_H \end{aligned}$$

Similarly, for the foreign country we have the budget constraint and first order condition

$$\begin{aligned} C_H^* + p^* C_F^* &= p^* Y_F \\ C_H^* &= p^{*\theta} C_F^* \end{aligned}$$

These lead to the solutions

$$\begin{aligned} C_H^* &= \frac{p^* p^{*\theta}}{p^* + p^{*\theta}} Y_F \\ C_F^* &= \frac{p^*}{p^* + p^{*\theta}} Y_F \end{aligned}$$

We solve the model by combining these demand functions with market clearing conditions to solve for equilibrium prices. The market clearing conditions are

$$C_H^* = (1-\tau)(Y_H - C_H)$$

and

$$C_F = (1-\tau)(Y_F - C_F^*)$$

(remember that because of the iceberg costs, proportion τ of the goods "melt away" in transit).

By Walras's law, one of the market clearing conditions is redundant. We can pick one of them, then use the goods market no-arbitrage condition (1) to express everything in terms of a single relative price (either p or p^*) and then solve for that market-clearing price.

Specifically, if we have

$$C_F^* = \frac{p^*}{p^* + p^{*\theta}} Y_F = \frac{1}{1 + p^{*(\theta-1)}} Y_F = \frac{1}{1 + [(1-\tau)^2 p]^{(\theta-1)}} Y_F$$

then clearing the market for foreign goods gives

$$\begin{aligned} C_F &= (1-\tau)(Y_F - C_F^*) \\ &= (1-\tau)\left(Y_F - \frac{1}{1 + [(1-\tau)^2 p]^{(\theta-1)}} Y_F\right) \\ &= (1-\tau)\left(\frac{[(1-\tau)^2 p]^{(\theta-1)}}{1 + [(1-\tau)^2 p]^{(\theta-1)}}\right) Y_F \end{aligned}$$

and plugging back in the home demand for foreign goods, we have one equation in the unknown p, namely

$$\frac{1}{p+p^{\theta}}Y_H=(1-\tau)\left(\frac{[(1-\tau)^2p]^{(\theta-1)}}{1+[(1-\tau)^2p]^{(\theta-1)}}\right)Y_F$$

This implicitly defines p as a function of the **relative** endowment Y_H/Y_F, the elasticity of substitution θ and the trade cost τ. Obstfeld and Rogoff focus on the **symmetric** case where the endowments of the two countries are of the same size, $Y_H=Y_F$ so that we need to solve

$$\frac{1}{p+p^{\theta}}=(1-\tau)\left(\frac{[(1-\tau)^2p]^{(\theta-1)}}{1+[(1-\tau)^2p]^{(\theta-1)}}\right)$$

To solve this, write the left hand side as

$$\frac{1}{p+p^{\theta}}=\frac{1}{p(1+p^{\theta-1})}=\frac{1}{p}\frac{(\frac{1}{p})^{\theta-1}}{1+(\frac{1}{p})^{\theta-1}}$$

(you will see why in a minute). So restating the problem

$$\frac{1}{p}\frac{(\frac{1}{p})^{\theta-1}}{1+(\frac{1}{p})^{\theta-1}}=(1-\tau)\left(\frac{[(1-\tau)^2p]^{(\theta-1)}}{1+[(1-\tau)^2p]^{(\theta-1)}}\right)\tag{4}$$

If you stare at this equation long enough, you will realize that the unique solution is

$$p=\frac{1}{1-\tau}$$

To verify that this is correct, plug it in to the left hand side of (4) to get

$$\frac{1}{p}\frac{(\frac{1}{p})^{\theta-1}}{1+(\frac{1}{p})^{\theta-1}}=(1-\tau)\frac{(1-\tau)^{\theta-1}}{1+(1-\tau)^{\theta-1}}$$

And also plug the guess into the right hand side to get

$$(1-\tau)\left(\frac{[(1-\tau)^2p]^{(\theta-1)}}{1+[(1-\tau)^2p]^{(\theta-1)}}\right)=(1-\tau)\left(\frac{[(1-\tau)^2\frac{1}{1-\tau}]^{(\theta-1)}}{1+[(1-\tau)^2\frac{1}{1-\tau}]^{(\theta-1)}}\right)=(1-\tau)\frac{(1-\tau)^{\theta-1}}{1+(1-\tau)^{\theta-1}}$$

Since the left and right hand sides are equal, the guess is correct. We then have the solutions for equilibrium price

$$p=\frac{1}{1-\tau},\qquad \text{all }\theta$$

and from the no-arbitrage relationship,

$$p^* = 1 - \tau, \qquad \text{all } \theta$$

From the first order conditions (2) and (3), equilibrium consumption ratios are

$$\frac{C_H}{C_F} = \frac{C_F^*}{C_H^*} = p^\theta = \frac{1}{(1-\tau)^\theta}$$

Hence we have that home expenditure on domestic goods relative to imports is

$$\frac{P_H C_H}{P_F C_F} = \frac{1}{p}\frac{C_H}{C_F} = p^{\theta-1} = \frac{1}{(1-\tau)^{\theta-1}} = (1-\tau)^{1-\theta} = p^* \frac{C_F^*}{C_H^*}$$

For example, if trade costs were zero, $\tau = 0$, then the relative price is $p = 1$ and the expenditure share in this case is 1 too (this is driven by the symmetry of the preferences and the endowments). If $\tau \to 1$, however, the relative price of foreign goods $p \to \infty$ and the expenditure share $\frac{1}{p}\frac{C_H}{C_F} \to \infty$ too so that all expenditure is on home goods (even with symmetric preferences and endowments).

Clearly, if τ is big enough, we can get any amount of home bias we like. Obstfeld and Rogoff's point, however, is that there is an important interaction with the elasticity of substitution between goods. The elasticity of the expenditure share with respect to trade costs is given by the calculation

$$\log\left(\frac{C_H}{pC_F}\right) = (1-\theta)\log(1-\tau)$$

so that

$$\frac{d}{d\tau}\log\left(\frac{C_H}{pC_F}\right) = -(1-\theta)\frac{1}{1-\tau}$$

and finally the elasticity is

$$\frac{d\log\left(\frac{C_H}{pC_F}\right)}{d\log(\tau)} = -(1-\theta)\frac{\tau}{1-\tau}$$

Suppose we fix τ. Then as $\theta \to \infty$ so that goods are better and better substitutes, the elasticity of the expenditure share with respect to trade costs becomes very large. For example if $\tau = \frac{1}{4}$ and $\theta = 2$, the elasticity is $\frac{1}{3}$, but if goods are much better substitutes and $\theta = 6$, then the elasticity of the expenditure share is 5 times larger at $\frac{5}{3}$. Notice that this elasticity also implies that the higher is the level of the trade cost, the bigger is the effect of a fall in trade costs on the expenditure share (i.e., the home bias). For example, if $\tau = \frac{9}{10}$ and $\theta = 2$, a 1% fall in trade costs leads to about a 9%

fall in the expenditure share on home goods while if $\frac{1}{10}$ and $\theta = 2$, a 1% fall in trade costs leads to about a 0.11% fall in the expenditure share.

Obstfeld and Rogoff take $\tau = \frac{1}{4}$ and $\theta = 6$ as a benchmark parameterization because it leads to an expenditure share of

$$\frac{1}{p}\frac{C_H}{C_F} = 4.2$$

which they argue is about right as a measure of the share of expenditure on imports versus home goods for OECD countries.

The key point is that with a relatively high elasticity of substitution, a large home bias can be explained even with moderate trade costs. While an elasticity of substitution parameter of the order of $\theta = 5$ or $\theta = 6$ is not very controversial, it is still debatable as to whether a number like $\tau = \frac{1}{4}$ is reasonable. Obstfeld and Rogoff argue that once one aggregates tariff and non-tariff barriers, transportation costs, and take into account that they stacked the deck in favor of **no** home bias by working with such a symmetric model, then $\tau = \frac{1}{4}$ is OK. For example, if one wrote down asymmetric preferences of the form

$$C = \left[C_H^{\frac{\theta-1}{\theta}} + \omega C_F^{\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}$$

and

$$C^* = \left[\omega C_H^{*\frac{\theta-1}{\theta}} + C_F^{*\frac{\theta-1}{\theta}} \right]^{\frac{\theta}{\theta-1}}$$

then $\omega < 1$ would do some of work of the trade costs parameter τ.

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