The Six Major Puzzles in International Macroeconomics: Is There a Common Cause?

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***What are the Main Open-Economy Macro Puzzles*?**

- Feldstein-Horioka (current accounts very small)
- Home bias in trade
- Home bias in equity portfolios
- Consumption correlations
- Pricing puzzle(s) (international price discrepancies, PPP puzzle)
- Exchange rate disconnect puzzles(s) (including Meese-Rogoff, Baxter-Stockman)

The Common Factor

National economies' product markets are less integrated than macroeconomists typically assume (a feature making international economics a distinct field).

We analyze trade costs (for goods and services – not financial assets) including physical transport costs, tariffs, and NTBs.

Conservatively, these easily reach 10% on many goods traded among industrial countries. (Higher for developing countries.)

Since Samuelson's (1954) analysis of the "transfer problem," there is surprisingly little work on effects of trade costs.

Putting these costs into otherwise standard international models, *we get striking explanatory power*.

The main thrust of our argument is not that trade costs are the only impediment to capital market integration.

Nor do we necessarily believe international capital markets are perfect (in the A-D sense). Rather, the argument is that one can explain the major puzzles without necessarily assuming that imperfections in international capital markets are **dramatically larger** than imperfections in domestic capital markets.

Home Bias in Trade

J. McCallum (AER, 1995) showed that in 1998 U.S.-Canada trade data, inter-province trade is 20 times international trade, holding other determinants of trade fixed.

Subsequent estimates have whittled this bias down to 6 to 12.

OECD data also confirm trade bias, which is fundamental to transfer problem, effects of fiscal policy, etc., and also figures in discussions of low factor content of trade (Trefler).

A simple model: Utility is

$$C = \left(C_H^{\frac{\theta-1}{\theta}} + C_F^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}},$$

C_H is home consumption of the home-produced good and C_F is home consumption of foreign-produced good.

Assume "iceberg" shipping costs τ, so that for every unit of home (foreign) good shipped abroad, only a fraction $1-\tau$ arrives at the foreign (home) shore.

Let P_H (P_F) be the home price of the home (foreign) good, and P_H^* (P_F^*) the corresponding foreign prices, with all prices measured in terms of a common world monetary unit.

Then, if markets are competitive, arbitrage implies that

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

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

Thus, if $p \equiv P_F/P_H$, and $p^* \equiv P_F^*/P_H^*$,

$$p^* = p(1-\tau)^2.$$

From the first-order conditions for utility maximization

$$\frac{C_H}{C_F} = p^{\theta}, \qquad \frac{C_H^*}{C_F^*} = (p^*)^{\theta}.$$

Combining the above equations, we have

$$\frac{C_H}{C_F} = (1-\tau)^{-2\theta}\left(\frac{C_H^*}{C_F^*}\right).$$

For illustrative purposes, consider the symmetric case in which $Y_H = Y_F$. Then the FOC simplifies to

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

This equation shows that the ratio of home (foreign) expenditure on imports relative to home (foreign) goods is

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

Thus, for example, if there were no trade costs ($\tau = 0$), $pC_F/C_H = 1$. If $\tau = 0.25$ (a high number for just traded goods but very conservative when applied to all of GNP) and $\theta = 6$, then $C_H/pC_F = 4.2$. This ratio is consistent with those we observe for many OECD countries, and it can easily be made higher by raising τ or raising θ. (We believe that $\tau > .25$ is reasonable for all GNP on average). Most estimates give a ballpark θ not very far from 6

The nonlinear relationship between trade costs and home bias in trade

The higher trade costs (the closer τ is to 1), the greater the impact of a one percent reduction in τ on home bias:

$$\frac{\mathrm{d}\log(C_H/pC_F)}{\mathrm{d}\log\tau} = \frac{\tau}{1-\tau}(\theta-1).$$

For our baseline case of $\tau = 0.25$ and $\theta = 6$, the elasticity of home bias with respect to trade costs is $\tau(\theta-1)/(1-\tau) = 1.67$.

Home Bias in Equities

U.S. equity holders hold only about 11.7% (O-R, 2000) of equity abroad. See figure 2

Standard models don't explain this home bias.

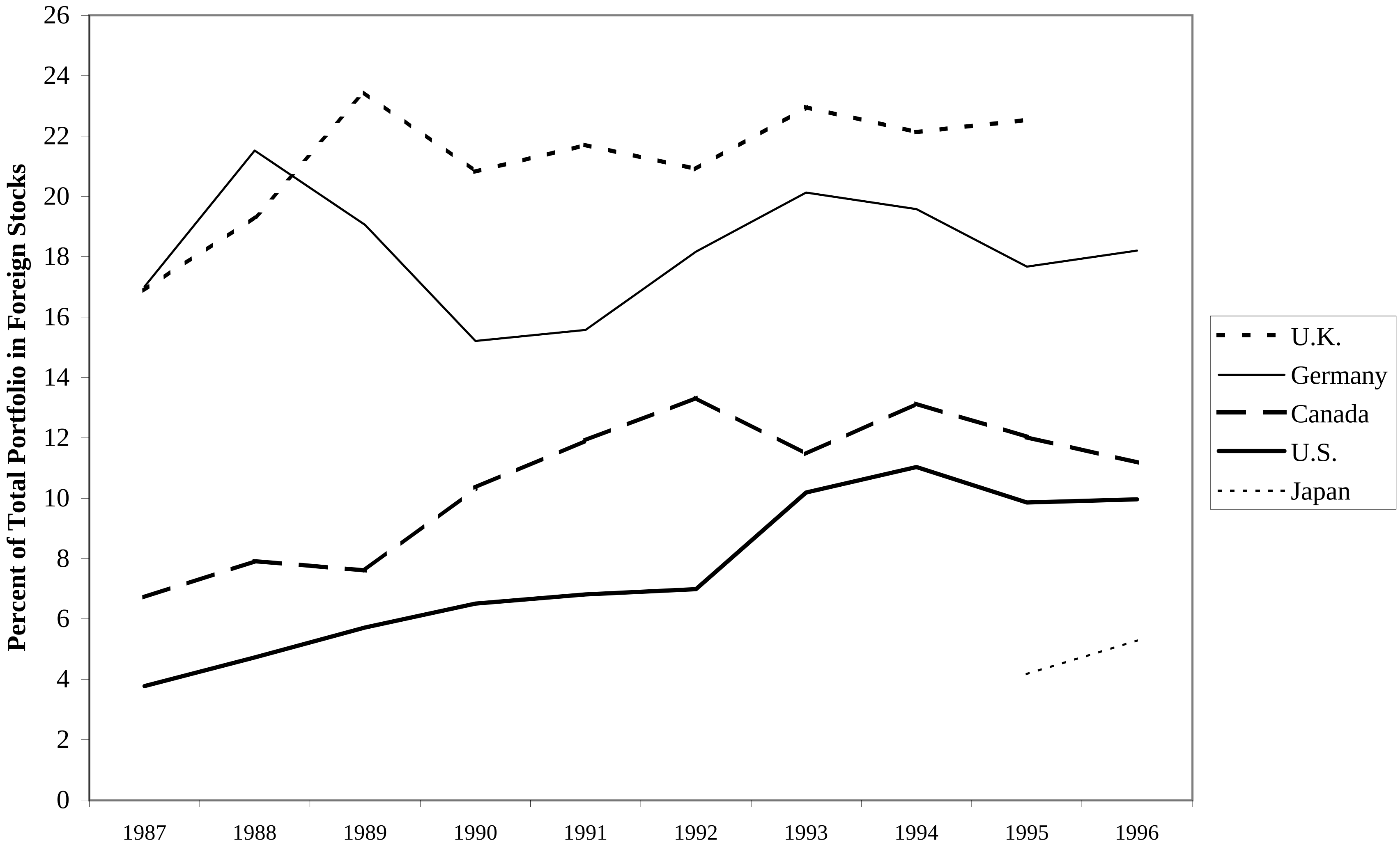
Figure 2 shows relevance for other countries.

Trade costs reduce the puzzle substantially.

Example: With $\theta = 10$ and $\tau = 0.1$, get home portfolio share of 0.72 (rather than 1/2) in home equities. Rises sharply as θ, τ rise.

(Rather insensitive to degree of risk aversion for realistic uncertainty levels.)

Figure 2: Home Bias in Equity Portfolios: 1987-1996*



*From Tesar and Werner (1998)

Preferences

$$\mathsf{E}U = \mathsf{E}\left\{ \frac{1}{1-\rho} \left[\left(C_H^{\frac{\theta-1}{\theta}} + C_F^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}} \right]^{1-\rho} \right\}$$

$$= \mathsf{E}\left\{ \frac{C^{1-\rho}}{1-\rho} \right\},$$

iceberg costs to trade

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

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

If both countries symmetric, free trade in Arrow-Debreu securities yields an allocation

$$\frac{1}{P_H}\frac{\partial U}{\partial C_H} = \frac{1}{P_H^*}\frac{\partial U^*}{\partial C_H^*},$$

and

$$\frac{1}{P_F}\frac{\partial U}{\partial C_F} = \frac{1}{P_F^*}\frac{\partial U^*}{\partial C_F^*},$$

for every state of nature, or

$$C_H^{-\frac{1}{\theta}} C^{\frac{1}{\theta}-\rho} = (1-\tau) C_H^{*-\frac{1}{\theta}} C^{*\frac{1}{\theta}-\rho}$$

and

$$(1-\tau) C_F^{-\frac{1}{\theta}} C^{\frac{1}{\theta}-\rho} = C_F^{*-\frac{1}{\theta}} C^{*\frac{1}{\theta}-\rho}.$$

Together these conditions imply the ex post consumption efficiency condition

$$\left(\frac{P_F}{P_H}\right)^{\theta} = \frac{C_H}{C_F} = (1-\tau)^{-2\theta}\frac{C_H^*}{C_F^*} = (1-\tau)^{-2\theta}\left(\frac{P_F^*}{P_H^*}\right)^{\theta}.$$

The model is closed by the output-market clearing conditions:

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

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

Four of the preceding five equations are independent and yield solutions for the consumption levels C_H, C_F, C_H^*, and C_F^*.

Evaluating the Home Bias

Helpful special case $\rho = 1/\theta$, in which case the Arrow-Debreu conditions simplify enormously. One can also show that the Arrow-Debreu allocation is then identical to the one in which people can trade only straight equity shares. Equilibrium portfolio shares as

$$
\begin{aligned}
x_H &= \frac{1}{1+(1-\tau)^{\theta-1}} Y_H, \\
x_H^* &= \frac{(1-\tau)^{\theta-1}}{1+(1-\tau)^{\theta-1}} Y_H, \\
x_F &= \frac{(1-\tau)^{\theta-1}}{1+(1-\tau)^{\theta-1}} Y_F^*, \\
x_F^* &= \frac{1}{1+(1-\tau)^{\theta-1}} Y_F^*,
\end{aligned}
$$

For $\theta = 6$ and transactions costs of $\tau = 0.25$ one obtains $x_H = 0.81$, $x_H^* = 0.19$. Since share prices will be equal due to symmetry, this implies a home bias of 81 percent. If $\theta = 10$ (still only half of Wei's suggestion of 20 for OECD countries), then the home portfolio share of home equities is 72 percent even with transactions costs of just 10 percent.

The preceding calculations require us to constrain the value of ρ to equal $1/\theta$, but, as we shall now demonstrate numerically, the results turn out to be remarkably insensitive to this assumption, given realistic levels of output uncertainty.

If we relax our restriction $\rho = 1/\theta$, the fragile conditions needed to implement the Arrow-Debreu allocation through equity trade alone are broken. Transport costs create an effective asymmetry between agents' utility functions and standard portfolio separation theorems no longer apply. Nevertheless, one can still gain a good deal of insight into home bias by computing the *state-contingent* consumptions of the two goods dictated by the Arrow-Debreu efficiency conditions.

See Table 4
$c_H \equiv C_H/Y_H, c_F \equiv C_F/Y_F, c_H^* \equiv C_H^*/Y_H,$ and $c_F^* \equiv C_F^*/Y_F$ depend only on the output ratio $y_H \equiv Y_H/Y_F$. Notice that Home's output shares decline across states of nature as its relative endowment rises.

Results turn out to be fairly insensitive to the value of the risk aversion coefficient ρ, This low sensitivity to ρ is related to the conjecture by Cole and Obstfeld (1991) that, for moderate uncertainty, the gains from global risk sharing may be so low as to be mostly offset by costs of trade. Stated differently, the equilibrium with a rich variety of assets is not so different from the one in which individuals can hold only equity.

Table 4: Portfolio Positions in Home and Foreign Goods

State of nature, $y_H \equiv Y_H/Y_F$.	**0.8**	**0.9**	**1.0**	**1.1**	**1.2**
Parameter settings		**Portfolio shares** $(\mathbf{c}_H, \mathbf{c}_F)$			
$\tau = 0.1, \theta = 2, \rho = 2$	0.53, 0.43	0.53, 0.43	0.53, 0.43	0.53, 0.43	0.52, 0.42
$\tau = 0.1, \theta = 3, \rho = 2$	0.56, 0.41	0.55, 0.40	0.55, 0.40	0.55, 0.40	0.55, 0.40
$\tau = 0.1, \theta = 5, \rho = 2$	0.61, 0.37	0.61, 0.36	0.60, 0.36	0.60, 0.35	0.60, 0.35
$\tau = 0.1, \theta = 6, \rho = 1/\theta$	0.63, 0.33	0.63, 0.33	0.63, 0.33	0.63, 0.33	0.63, 0.33
$\tau = 0.1, \theta = 6, \rho = 2$	0.64, 0.35	0.63, 0.34	0.63, 0.33	0.62, 0.33	0.62, 0.32
$\tau = 0.1, \theta = 6, \rho = 5$	0.64, 0.35	0.64, 0.34	0.63, 0.33	0.62, 0.33	0.62, 0.32
$\tau = 0.2, \theta = 2, \rho = 2$	0.56, 0.36	0.56, 0.36	0.56, 0.36	0.55, 0.35	0.55, 0.35
$\tau = 0.2, \theta = 6, \rho = 1/\theta$	0.75, 0.20	0.75, 0.20	0.75, 0.20	0.75, 0.20	0.75, 0.20
$\tau = 0.2, \theta = 6, \rho = 2$	0.78, 0.22	0.76, 0.21	0.75, 0.20	0.74, 0.19	0.73, 0.18
$\tau = 0.2, \theta = 6, \rho = 5$	0.78, 0.22	0.77, 0.21	0.75, 0.20	0.74, 0.18	0.73, 0.18
$\tau = 0.3, \theta = 6, \rho = 2$	0.89, 0.13	0.87, 0.11	0.86, 0.10	0.84, 0.09	0.83, 0.08
$\tau = 0.3, \theta = 8, \rho = 2$	0.95, 0.08	0.94, 0.07	0.92, 0.05	0.91, 0.04	0.89, 0.04

A caveat: transaction costs, and the resulting home bias, would be reduced somewhat in a fully dynamic model, because investors could reinvest dividends abroad rather than repatriating them immediately.

Feldstein-Horioka* (1980) *puzzle

For OECD data from 1960-mid 1970s, cross section regression of average investment on saving yielded slope near 1.

In more recent OECD data, coefficient is still 0.6, too high to explain easily in a world of capital mobility.

If this means capital is immobile, one is puzzled, since nominal returns are *very* closely arbitraged.

Our point: cost of international trade can drive a big wedge between countries' real interest rates, even under costless international trade in claims to income streams.

One-Good*, *Two-Period Model

Let world interest rate be i^*. When country is a net importer pf goods, prices are higher than when it is a net exporter.

This has (domestic) real interest rate effect.

Assume Samuelsonian “iceberg” trade cost, τ%.

Domestic real interest rate $1 + r$ is bracketed by the international lending and borrowing rates

$$[(1 + i^*)(1 - \tau)^2, (1 + i^*)/(1 - \tau)^2].$$

For $i^* = 0.5$ and $\tau = 0.1$ this range is [0.85,1.30].

Two-Good Model

Several qualifications, including multiple goods. If we export less rather than importing more, we can consume more without raising the domestic price.

This kills one-good model's prediction of extensive autarky.

Figure 1 indicates how real (domestic) interest rate varies with first-period expenditure.

Numerically, we still get a large range of domestic real interest rates. For earlier parameters, and $\theta = 6$ (θ is intratemporal substitution elasticity), spread is [0.92, 1.20]

As $\theta \rightarrow \infty$, this spread widens.

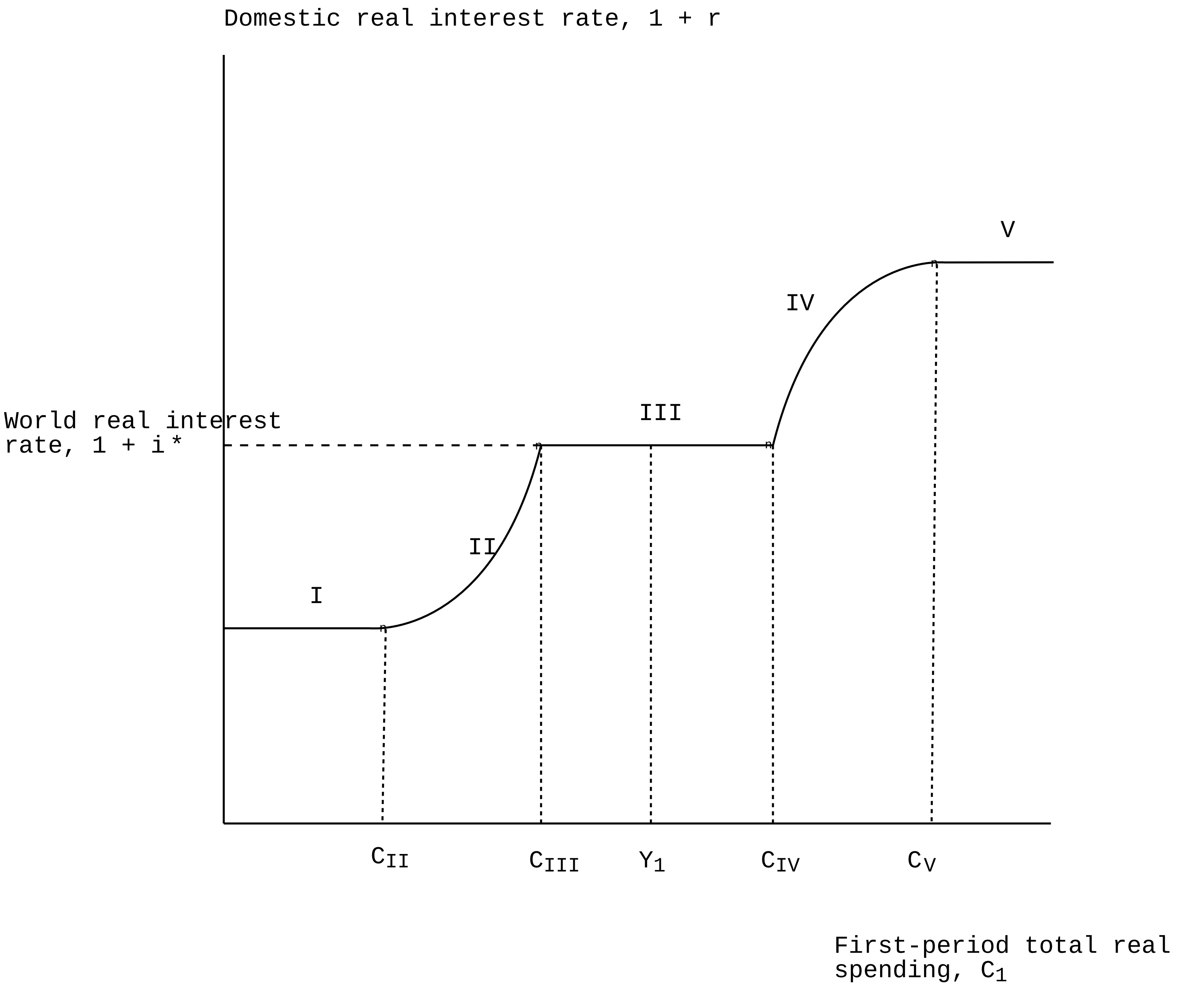


Figure 1: Domestic spending and the domestic real interest rate in a two-good model with trade costs.

Analytics

Utility function

$$U(C_1, C_2) = \frac{C_1^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}} + \beta \frac{C_2^{1-\frac{1}{\sigma}}}{1-\frac{1}{\sigma}}$$

$$C = \left(C_H^{\frac{\theta-1}{\theta}} + C_F^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}}, \ \theta > 1.$$

small country, exogenous endowment profile $Y_{H,1},\ Y_{H,2}$. No endowment of foreign good. (Endowing the country with both goods would not weaken our argument.)

Assume an international unit of account world nominal ($=$ real) interest rate i^*, Nominal prices P_H^* and P_F^*.

Same transport cost τ for both goods.

The first period budget

$$P_{H,1}Y_{H,1} + D = P_{H,1}C_{H,1} + P_{F,1}C_{F,1} = P_1C_1$$

Overall home price level is

$$P = (P_H^{1-\theta} + P_F^{1-\theta})^{\frac{1}{1-\theta}}.$$

Second period budget constraint

$$P_{H,2}Y_{H,2} - (1+i^*)D =$$

$$P_{H,2}C_{H,2} + P_{F,2}C_{F,2} = P_2C_2,$$

Consolidated intertemporal budget constraint

$$P_1C_1 + \frac{P_2C_2}{1+i^*} = P_{H,1}Y_{H,1} + \frac{P_{H,2}Y_{H,2}}{1+i^*}$$

Or, in terms of the domestic real interest rate $1+r = (1+i^*)P_1/P_2$

$$C_1 + \frac{C_2}{1+r} =$$

$$\frac{P_{H,1}Y_{H,1}}{P_1} + \left(\frac{1}{1+r}\right)\frac{P_{H,2}Y_{H,2}}{P_2}.$$

$$C_H = \left(\frac{P_H}{P}\right)^{-\theta}C, \;\; C_F = \left(\frac{P_F}{P}\right)^{-\theta}C.$$

Domestic price of (consistently) imported good is $P_F = P_F^*/(1-\tau)$. Assume many alternative suppliers of the home good at price P_H^*.

If home good is exported ($C_H < Y_H$), $P_H = P_H^*(1-\tau)$;

If imported ($C_H > Y_H$) its domestic price is $P_H = P_H^*/(1-\tau)$. P_H

If $C_H = Y_H$?

Large current account deficits (surpluses) can alter the time path of P_H and potentially drive a wedge between domestic and foreign real interest rates.

See figure 1 plots C_1, against $1+r$. Five-segment step function. Think of β varying as other parameters are constant.

Segment 1, C_1 is so low, current account surplus is very high $\rightarrow C_{H,2} > Y_{H,2}$.

Since in period 2 the home good must be imported, while in period 1 it is exported, we have

$$
\begin{aligned}
1+r &= \frac{(1+i^*)\left(P_{H,1}^{1-\theta}+P_F^{1-\theta}\right)^{\frac{1}{1-\theta}}}{\left(P_{H,2}^{1-\theta}+P_F^{1-\theta}\right)^{\frac{1}{1-\theta}}} \\
&= \frac{(1+i^*)\left\{\left[P_H^*(1-\tau)\right]^{1-\theta}+P_F^{1-\theta}\right\}^{\frac{1}{1-\theta}}}{\left\{\left[P_H^*/(1-\tau)\right]^{1-\theta}+P_F^{1-\theta}\right\}^{\frac{1}{1-\theta}}} \\
&< 1+i^*
\end{aligned}
$$

in segment I.

Segment II starts when period 1 consumption first reaches the level C_{II} such that $C_{H,2} = Y_{H,2}$. In this region, $P_{H,2}$ is determined price index equation and the equation governing demand for $C_{H.}$ (with $C_{H,2} = Y_{H,2}$).

Period 2 consumption of the home good remains constant at $Y_{H,2}$ as long as $P_{H,2}$ remains strictly between $P_H^*(1-\tau)$ and $P_H^*/(1-\tau)$, but $P_{H,2}$ falls as C_1 rises and C_2 falls, until $P_{H,2}$ reaches $P_H^*(1-\tau)$. Accordingly, the real interest rate *rises* over segment II.

Segment III begins as the home country becomes a period 2 exporter of its endowment good.

On this stretch, $1+r = 1+i^*$. Because here, $C_H < Y_H$ in both periods, the overall price level is constant over time. No effect on the real interest rate.

$C_1 = C_{IV}$, $C_{H,1}$ reaches $Y_{H,1}$, and the real interest rate begins to rise once more.

In segment IV, $C_{H,1}$ remains stuck at $Y_{H,1}$ as C_1 rises, pushing $P_{H,1}$ up with it until $P_{H,1}$ reaches $P_H^*/(1-\tau)$. As $P_{H,1}$ rises along segment IV, with $P_{H,2}$ constant at $P_H^*(1-\tau)$, the real interest rate rises.

At C_V, however, where $P_{H,1}$ first reaches $P_H^*(1-\tau)$, the country becomes a period 1 importer of its own endowment good and the real interest rate stabilizes (along segment V) at the level

$$1 + r = \frac{(1+i^*)\left\{[P_H^*/(1-\tau)]^{1-\theta} + P_F^{1-\theta}\right\}^{\frac{1}{1-\theta}}}{\left\{[P_H^*(1-\tau)]^{1-\theta} + P_F^{1-\theta}\right\}^{\frac{1}{1-\theta}}}$$

$$> 1 + i^*.$$

The range of possible real interest rates for the small country is not quite as broad as in the one-good case, $i^* = 0.05, \tau = 0.1, \theta = 6$, and $P_H^* = P_F^* = 1$, we find that the highest possible real interest rate is 20 percent (15 percent above the world level) while the lowest is -8 percent (13 percent below the world level). There is an interesting interplay between the commodity transport costs τ and the substitution elasticity θ. (This interplay will return in other contexts below.) As $\theta \to \infty$ the two goods are asymptotically perfect substitutes and we get results from one good case.

The range of real domestic interest rates allowed by the model is greater than what we usually observe in practice (especially for OECD countries). However, country can be an international borrower or lender without reaching the extremes of the interest range. Indeed, small current account imbalances do not create any wedge between home and foreign real interest rates.

Note: with many goods, kink smoothens, qualitative results the same. Also note: We can get similar results with other, more conventional models, e.g., traded nontraded goods (but quantification clearer here)

Test: See table 2

Table 2

Real Interest Rates and the Current Account, 1975–1998

	Coefficient on $\frac{CA}{GDP}$	**Significance**	ρ	$\mathbf{R^2}$
Specification 1				
OLS	-36.9	0.00	0.65	0.05
Country fixed effects	-46.3	0.00	0.65	0.08
Country fixed effects, time dummies	-32.3	0.00	0.55	0.50
Specification 2				
OLS	-17.9	0.00	0.58	0.02
Country fixed effects	-19.4	0.00	0.58	0.05
Country fixed effects, time dummies	-18.9	0.01	0.54	0.32

The dependent variable is the annualized three-month nominal interest rate less lagged annual inflation CPI rate (specification 1) or less the contemporaneous inflation rate (specification 2). The sample uses annual data and covers the years 1975-98 and all OECD countries except Iceland, Korea, Mexico, and Turkey. Current accounts (as a percent of GDP) are reported by the OECD. We use three-month interest rates, usually a treasury bill rate but an interbank rate if no government rate is available. These data come from *International Financial Statistics* and the OECD. CPI inflation rates are based on IFS data. For the specification 2 regressions, four countries did not report monthly interest rate data until after the start of our sample. The countries, with their starting dates in parentheses, are Spain (1977), Greece (1980), Portugal (1985), and Finland (1987).

Consumption Correlations Puzzle

Unlike other puzzles, the various consumption correlation puzzles tend to be very model specific. Much less fundamental than other puzzles

Simplest model with PPP and homogeneous tastes predicts equal consumption growth worldwide:

$$\frac{C_{t+1}}{C_t} = \frac{C^*_{t+1}}{C^*_t}$$

But this fails miserably. Basically a corollary of the home bias in risky asset allocation, and Feldstein Horioka puzzles

There is a more sophisticated variant when PPP fails, the “Backus-Smith” condition

$$\frac{C_{t+1}^{-\rho}/P_{t+1}}{C_t^{-\rho}/P_t} = \frac{C_{t+1}^{*-\rho}/P_{t+1}^{*}}{C_t^{*-\rho}/P_t^{*}}$$

With perfect risk sharing, then, if exchange rate moves sharply between A+B, a large transfer should take place (in *theory*) to country whose price level has unanticipatedly dropped. This condition fails even more miserably empirically.

B-S puzzle seems to require that international capital markets be much MORE developed than domestic ones.

Finally there is the Backus-Kehoe-Kydland (JPE 1992) puzzle that per capita consumptions are less correlated internationally than outputs; see table 5. Why this is a puzzle is not obvious. Consumptions *are* more correlated that levels of consumable output, $Y - I - G$, which would appear to be the more relevant comparison. See table 6

Pricing Puzzles

Include prevalence of pricing to market and large deviations from Law of One Price.

Big effects of nominal exchange rate changes on relative prices.

PPP puzzle of slow mean reversion.

These are explicable by trade costs, which create “no-arbitrage” bands within which PTM is possible and LOOP deviations are very persistent.

For CPI level data, PTM is even more *extreme, and virtually all consumer goods appear priced (stickily) in local currency.

Engel (1999) shows that at consumer level, no distinction between behavior of “traded” and “nontraded” goods prices.

There must be very high retailing costs

between port of entry and final consumers

Exchange Rate Disconnect

Transport costs, PTM, and local-currency pricing help explain a “disconnect” between exchange rates and fundamentals (including output-market prices).

In a flexible-price model, we show how trade costs can result in exchange rate indeterminacy (an extreme form of volatility).

An example of a model with local-currency pricing of consumer goods leads to the exchange rate equation:

$$e = \frac{m - m^*}{1 - \alpha} - \frac{\alpha(p_C - p_C^*)}{1 - \alpha},$$

where $1 - \alpha$ is the share of flex-price freely tradable consumer goods.

As $\alpha \to 1$, volatility is unbounded. The tail wags the dog?

Of course, there is a reverse feedback channel from exchange volatility to trade costs, since emerging theory and evidence suggest that exchange volatility acts as a tax on trade.