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**Measuring the Degree of Capital Mobility:
What does the Feldstein-Horioka Equation test?**

by

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**Measuring the Degree of Capital Mobility:
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A huge literature on the Feldstein-Horioka puzzle has appeared since Martin Feldstein and Charles Horioka (1980) regressed national investment rates on savings rates and, finding coefficients close to unity, could not reject the hypothesis that capital is internationally immobile. Subsequent empirical studies have mostly found coefficients significantly less than unity, rejecting the null hypothesis of immobile capital. National coefficients do, however, differ significantly from zero; interpreted as indicating limited capital mobility in a world of integrated capital markets, this empirical regularity has been dubbed the Feldstein-Horioka (FH) puzzle.

Recent papers in the *American Economic Review* by Marianne Baxter and Mario Crucini (1993), by Robert Barro et al. (1995) and by Roger Gordon and Lans Bovenberg (1996) have addressed the FH puzzle by developing theoretical reasons for why I/Y and S/Y may be highly correlated even when capital is internationally mobile. Meanwhile, papers in the *Economic Journal* by Atish Ghosh (1995) and by Jerry Coakley et al. (1996) have explained the stylized fact of a unit FH coefficient in econometric terms. I will argue that these contributions are misguided, insofar as they are based on misinterpretation of the empirical evidence.

The FH regression provides a reasonable test of capital immobility, but not of capital mobility. The fallacy has been to treat a zero coefficient as a necessary, rather than a sufficient, condition for capital mobility. The error has been compounded by using the FH coefficient as a measure, on a 0-1 scale, of the degree of capital immobility. These steps are logically fallacious and results from three settler economies, presented in section 4, indicate that the 0-1 scale does not even pick up a reliable empirical regularity. The conventional view that the FH literature indicates an unexpectedly low degree of capital mobility is

groundless.

1. The FH Puzzle and the Usual Suspects

Feldstein and Horioka (1980), using panel data from sixteen OECD countries for 1960-74, regressed gross domestic investment rates (I/Y) on gross domestic saving rates (S/Y):

$$I/Y = a + b(S/Y) + u$$

and obtained an OLS coefficient for b which did not differ significantly from one but was significantly different from zero. By the FH test capital was not perfectly mobile internationally, because $b > 0$, and they could not reject the hypothesis that OECD countries were insulated from world capital markets, reflected in the value $b = 1$. The result was viewed as a paradox, because capital was considered to be mobile among OECD countries in the 1960s and 1970s.

What if different samples are used? The FH paradox appears to be robust for the 1960s and 1970s; none of the many cross-country studies following FH could reject the hypothesis that b differed significantly from zero (Susanne Lapp, 1996). Recalculating savings rates,¹ using net rather than gross figures, changing the sample countries, or dividing the sample into sub-periods does not alter the result. Large countries are more likely to be self-sufficient in providing their investment needs or to have an impact on world interest rates, but correcting for the influence of country size does not resolve the FH paradox. Applying the FH test to different decades has generally produced smaller values for b in the 1980s and before 1929 and higher values for the 1930s, which matches prior beliefs of greater capital mobility in the former

¹ There are two major data issues. National income accounts measures of savings differ from true savings when firms internally finance their investment and when foreigners own shares. In data for earlier decades savings are often measured by investment plus the current account surplus. Neither of these measurement issues makes a significant difference to the empirical results.

eras and less in the 1930s.

FH justified their use of cross-section data by arguing that parallel movement of S and I during the business cycle would upwardly bias coefficients based on time series analysis. Alessandro Penati and Michael Dooley (1984), Maurice Obstfeld (1986) and Stefan Sinn (1992) have used time series and found that the estimated coefficient is generally lower than in cross-section studies, significantly different from both one and zero. Thus, although FH's view of the time series bias appears to have been wrong, the hypothesis of perfectly mobile capital still has to be rejected and the time series results generate the same range, $0 < b < 1$, as the cross-sectional studies.

The FH paradox is heightened by results from markets known to have mobile capital. Stefan Sinn (1992) for forty-nine US states and Tamim Bayoumi and Andrew Rose (1993) for eleven regions of the UK found that the regression coefficient did not differ significantly from zero. This result could be interpreted as supporting the FH test of capital mobility ($b=0$), and heightening the puzzle of why the same result was not found in international studies for recent decades, when the OECD countries appear to have been integrated into international capital markets.

The overall pattern of the empirical literature is to suggest that b is appropriate as a test of capital immobility ($b=1$) or mobility ($b=0$), and that the scale $0-1$ can be used as a guide to the degree of capital immobility. The puzzle is why b is so much closer to unity than to zero for international capital flows in the second half of the twentieth century.

2. Theoretical Responses

Several theoretical contributions have argued that b may be biased upwards towards unity, even in the presence of capital mobility. If S and I have common underlying determinants, then they will move together, or this may be ensured by a feedback mechanism. Another branch of the theoretical literature emphasizes

that international capital markets are by their nature imperfect because human capital cannot be used as collateral for international borrowing. Finally, a large number of models has been developed which yield values of $b=1$ with mobile capital.

Maurice Obstfeld (1986) raised the general endogeneity problem; if S/Y and I/Y move together, then a coefficient $b>0$ is to be expected whether international capital markets function well or poorly. Jeffrey Frankel (1992) emphasises that $b=0$ requires not only real interest rate parity but also that any and all determinants of I other than the real interest rate must be uncorrelated with S , which is a strong requirement. Paul Krugman and Maurice Obstfeld (1994, 660) refer to this as "the main problem with the Feldstein-Horioka argument", while observing that the paradox "seems to have weakened recently in the face of the historically high external imbalances of the United States, Germany, and Japan". This double-edged assessment suggests that the FH test applies in some but not all contexts. Even more troubling are the findings from intra-national studies of $b=0$; there is little reason to believe that S and I have common determinants at the US national level but not at the individual state level, or at the UK national level but not in regions of the UK.

A reason why national coefficients might differ from internal coefficients is if national governments use fiscal policy to respond to current account imbalances. Thus, if a current account deficit leads to cutbacks in the government budget deficit, then gaps between I/Y and S/Y will be reduced, and b will be positive (Uwe Westphal, 1983). Whether governments do in fact react systematically to capital flows by altering the fiscal balance is itself an empirical issue.²

² Stephen Miller (1988, 34) invokes the maintained external balance hypothesis to explain the difference between pre- and post-1971 estimates of b for the USA (positive during the fixed exchange rate period, but zero under floating exchange rates).

Robert Barro and others have argued in several contexts that the neoclassical assumption of perfect capital mobility is inappropriate. Their critique is most powerful when human capital is included in the production function and the aim is to explain slow convergence, but Barro et al. (1995) specifically apply the argument to the FH puzzle. Capital markets cannot be perfect because human capital cannot be used as collateral; thus b must be positive and a null hypothesis of $b=0$ will always be rejected. In the FH context, this argument is undermined by the intra-national studies which found $b=0$. Admittedly, there may be some mechanisms for borrowing domestically on the basis of human capital, but these are limited and the differences in this respect between US, UK and world capital markets are a matter of degree, unlikely to support a distinction between the possibility of $b=0$ in the first two cases and not in the last.

Most of the theoretical literature making explicit reference to the FH puzzle consists of models which resolve the paradox by generating values of $b>0$ with capital mobility. Maurice Obstfeld (1986) and Linda Tesar (1991) have developed an array of models generating values of $b>0$. Other model builders have taken the stylized fact of $b=1$ as a starting point and judge the empirical relevance of their model by its success in generating $b=1$. Gordon and Bovenberg (1996, p.1057) open with a synthesis of the empirical literature:

In general, these papers find that additional savings in a country lead almost dollar for dollar to extra investment in the country.

and they explain the phenomenon by asymmetric information. Their model is entirely in terms of direct foreign investment, finessing the role of financial intermediaries in overcoming information asymmetries between borrowers and lenders as well as the informational advantages of transnational corporations who may be less familiar with the local scene than domestic investors but more familiar with the industry. Baxter and Crucini (1993) focus on the

consumption-smoothing property of capital flows to construct a model in which $b=1$. Models of the current account which ignore differences in investment opportunities or trade flows are, like the representative individual model of Gordon and Bovenberg, simplistic.³ The Baxter-Crucini and Gordon-Bovenberg models are also inconsistent with the empirical literature, which generally rejects the hypothesis $b=1$.

3. Econometric Responses

Econometric debates over the FH puzzle initially focussed on the large country, errors in variables and missing variables problems summarized in section 1. Over the last decade, however, they have centred on the cointegration issue. Stephen Miller (1988) and Jos Jansen and Günther Schulze (1996) argue that OLS is an inappropriate estimation technique due to the non-stationarity of I and S , and error correction methods are necessary. If I and S are cointegrated, then OLS estimates of b will converge to unity (Atish Ghosh, 1995, 108).

The solvency constraint has also been invoked to justify the use of error correction methods. Jerry Coakley et al. (1996) model the need for long-run external balance by including in the investment equation a risk premium term linked to the current account; this acts as an error correction process, ensuring long-run solvency and cointegration of S and I with a b coefficient which tends to unity. The solvency constraint is, however, not necessarily binding in reality; current account deficits can exist indefinitely if returns are higher in one country than in another, and historically this has occurred over multi-decade time horizons (eg. in Canada). In practice, ECMS do not yield hugely different results to OLS estimates. Alan Taylor (1996), with the biggest

³ Ghosh (1995) uses a consumption-smoothing model to derive benchmark current account gaps, which he then compares with actual capital flows and concludes that there is too much capital mobility.

panel used so far, obtains from an error correction model b estimates which are confirmatory of the results summarized in section 1. In general, both ECM and OLS estimates of b differ significantly from unity, disproving Ghosh's contention and the presumption of Coakley et al.

4. FH tests for settler economies

Before drawing conclusions about this literature, I will present FH results for three countries whose integration into world capital markets is well-documented. The settler economies of Argentina, Australia and Canada during the gold standard era had ready access to the London market, and no restrictions on capital flows. In each country, I/Y and S/Y were most likely independently determined.⁴

Table 1 presents OLS estimates of the Feldstein-Horioka equation.⁵ The first line for each country is for the longest available pre-1929 period, while the other two lines are for the longest common pre-1914 period (1885-1914) and for the classic gold standard/wheat boom era 1896-1914. The qualitative results do not vary much with the period, but are substantially different for each of the three countries. Only Argentina fits the classic FH test of capital mobility with $b=0$ and a low R^2 . The Australian results are similar to most empirical findings, with b significantly different

⁴ Savings rates in settler economies are driven by the demographic composition (Ian McLean, 1994; Alan Taylor, 1992). Investment is driven by natural resource availability, which in the decades covered in Table 1 reflected the big difference in accessible farmland, with Argentina best-placed in the 1890s and Canada after the turn of the century (Jeremy Adelman, 1994; Ian McLean, 1996; Alan Taylor, 1997).

⁵ Miller (1988) and Jansen and Schulze (1996) discuss co-integration between S/Y and I/Y and the need for using an error-correction model. I use OLS because there is no evidence from the settler economies of an intertemporal budget constraint (current account deficits were run for decades) and the OLS coefficients do not differ much from ECM estimates in Taylor (1996).

from both zero and one. Canada has the most surprising estimated coefficient with high b (not significantly different from unity for 1885-1914) and high R^2 for the pre-1914 periods. Interpreting these results as indicating that Australia and Canada were not integrated into international capital markets flies in the face of all the historical literature.

In the Australian and Canadian results in Table 1 the intercept, a , is large and significant for the longest period. This reflects both countries' ability to run long-term current account deficits, which is in itself conclusive evidence of integration into international capital markets. Not only were foreigners willing to lend to Canada and to Australia, but they were sufficiently confident of their investment that they were willing to relend rather than seek a net balance in the capital flows.

The significantly positive b coefficients and high R^2 suggest that S and I have common determinants. If, however, b differs from unity, then the implication is of some capital mobility. The extreme example is the estimate $b=1.998$ for Canada 1896-1914. Suppose that both S and I were positively related to the growth rate of income and output, but S was growing twice as fast as I ; capital mobility is a prerequisite for this to be feasible as the I - S gap will be widening. Without capital mobility, investment growth will be constrained and output growth will be slower.

The Australian coefficients, $b < 1$, can be supported by a different interpretation. The literature on the Australian financial crisis of the early 1890s suggests that the colonial governments reacted to the current account balance (McLean, 1996).

When increases in I threatened to exacerbate the deficit, governments cut spending in order to reduce income and hence imports and saving, a causal chain likely to produce a value of b between zero and one.

In sum, the three settler economies present three different pictures of capital mobility within the FH framework. Argentina

satisfies the classic FH test. Australia has $0 < b < 1$, but the positive intercept indicates that the relationship between investment and domestic saving was not imposed by capital immobility and the literature suggests that Australia is an example of the maintained external balance feedback mechanism (or of the solvency constraint working preemptively from the borrower's side).

Canada in the wheat boom era exhibits a third pattern of capital mobility with b significantly larger than unity; changes in investment and domestic saving may have had a common origin associated with rapid growth, but the response of I/Y exceeds that of S/Y so that increased capital inflows are required.

FH-type analysis of quantity flows provides a useful guide to capital mobility, but requires more subtlety of interpretation than simply testing for $b=0$. The FH test works better, although still imperfectly, as a test for capital immobility; $a=0$ and $b=1$ are very likely to be associated with immobile capital, although it could still arise with mobile capital if a country's capital scarcity exactly matches global capital scarcity (ie. if the domestically determined interest rate happens to equal the world interest rate).

The FH test of $b=0$ is sufficient to indicate capital mobility, as with Argentina before 1929, but the Australian and Canadian evidence shows that capital mobility can be consistent with any b value (including $b > 1$).

5. What does the FH test really tell us?

The FH literature revolves around a logical fallacy and an inaccurate stylized fact. While it is true that capital immobility implies $b=1$ and that $b=0$ implies mobile capital, $b=1$ does not necessarily imply capital immobility and $b=0$ is not a necessary condition for capital mobility. If capital is mobile, then b can assume any value. This has been recognized (eg. by Jansen and Schulze, 1996), but the prevailing practice has been to use $b=0$ as the test for capital mobility and to accept the 0-1 scale as a measure of the degree of capital mobility. Existing empirical

studies provide some plausibility for using the 0-1 scale as a rule of thumb, but the results for settler economies presented in the previous section show that the association between low b values and high capital mobility is not even an empirical regularity.

The most striking result from the FH literature since Feldstein and Horioka's initial contribution is the frequency with which the null hypothesis $a=0$ and $b=1$ can be rejected. Capital is not immobile. Theoretical and econometric critiques based on the "stylized fact" that $b=1$ are aiming a false target, and if they hit that target it is meaningless. There is no puzzle to be resolved.

Unfortunately we cannot go further and devise a simple measure of the degree of capital mobility based on the FH equation.

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Table 1: OLS Estimates of the Feldstein-Horioka Equation:
Canada, Australia and Argentina pre-1929

	a	b	R ²
<u>Canada</u>			
1870-1929	0.087 (0.017)	0.743 (0.129)	0.36
1885-1914	0.035 (0.021)	1.301 (0.157)	0.71
1896-1914	-0.078 (0.052)	1.998 (0.336)	0.68
<u>Australia</u>			
1861-1929	0.106 (0.010)	0.493 (0.085)	0.33
1885-1914	0.110 (0.016)	0.409 (0.133)	0.25
1896-1914	0.075 (0.012)	0.546 (0.087)	0.70
<u>Argentina</u>			
1885-1929	0.103 (0.006)	0.007 (0.068)	0.00
1885-1914	0.105 (0.008)	0.076 (0.093)	0.02
1896-1914	0.099 (0.017)	0.211 (0.200)	0.06

Notes: standard errors are in parentheses

Data Source: Taylor (1996, Appendix tables 1&2), based on a variety of sources for Argentina, Urquhart (1988) for Canada, and N. Butlin (1962), M. Butlin (1977) and McLean (1994) for Australia. The savings rates are calculated residually from the current account; Taylor makes some minor adjustments to the earlier sources to correct for gold flows and changes in stocks, drawing on work by Matthew Jones and Maurice Obstfeld.