Two Decades of the Feldstein-Horioka Puzzle:

Has the Puzzle Been Solved Yet?

Somchai Amornthum

Research Paper for Econ 662
International Monetary Economics

Department of Economics
University of Hawai'i at Manoa

November 25, 2003

Abstract

The Feldstein-Horioka puzzle is one of the most well known puzzles in the field of international macroeconomics. They argue that if the capital is perfectly mobile, there should be no relationship between domestic savings and investment. However, empirical studies usually find a very strong relationship between them. This has spawned a large amount of literature trying to explain why saving and investment appear to be correlated. The explanations have gone in many directions including common factors, exchange rate regimes, heterogeneity of countries, government policies, etc. Some of these attempts may be very convincing but happen to be empirically inadequate, while the others may have strong empirical supports but cannot explain why the relationship differs across time or country. Even though we have learned a great deal about the puzzle for the past two decades, the puzzle still goes on.

Contents

Two Decades of the Feldstein-Horioka Puzzle: Has the Puzzle Been Solved Yet?

I. INTRODUCTION

International macroeconomics is a field full of "puzzles", the perplexing stylized facts that are inconsistent with theories. The number of puzzles may range from 5 to 15 depending on author. However, no matter what list is being looked at, the Feldstein-Horioka puzzle must certainly be included in there. This puzzle looks at savings and investment relationship and the issue of capital mobility. Feldstein and Horioka (1980) argue that if the capital is perfectly mobile, people should be able to invest in countries where the rates of returns are higher. As a result, there should be no relationship between domestic savings and investment. This condition usually fails to find empirical supports. Consequently, there has been an enormous amount of literatures trying to solve this puzzle. The objective of this paper is to provide a survey of theoretical and empirical literatures on the Feldstein-Horioka puzzle. This paper is divided into 5 sections. Section II explains the puzzle, while section III describes the 6 leading explanations. A few alternative measures for capital mobility proposed in the past are discussed in section IV. Conclusions and suggestions in the last section then complete this paper.

II. THE FELDSTEIN-HORIOKA PUZZLE

Prior to 1980, international macroeconomics had suffered from the lack of proper yardstick to test for the perfect capital mobility hypothesis. All price measures such as the purchasing power parity and the uncovered interest parity, which seem to be sensible theoretically, have repeatedly failed in empirical studies. In their seminal paper, Martin

Feldstein and Charles Horioka (1980) introduced a new measure of financial integration, based on a quantity criterion. Looking at the relationship between domestic saving and investment rates, they argue that if the capital is perfectly mobile, people should be able to invest in countries where the rates of returns are higher. Any increase in savings in one country should result in an equally increase in investment of all counties[1]. As a result, there should be no relationship between the domestic saving and investment rates.

To test the hypothesis, Feldstein and Horioka (henceforth FH) perform the following cross-section regression based on data from 16 selected OECD countries between 1960 and 1974.

$$\left(\frac{I}{Y}\right)_i = \alpha + \beta \left(\frac{S}{Y}\right)_i \qquad (1)$$

where I = gross domestic investment, Y = gross domestic products, S = gross domestic saving, and i denotes countries. According to FH, the value of β (henceforth the FH coefficient) implies by perfect capital mobility should be zero, which means that there is no relationship between savings and investment (S-I hereafter). In contrast, an estimate of β close to one would reveal that most of the increase in savings remains in the country.

Concerning over the short-run cyclical pattern, FH used 5- and 15-year average of both rates to represent the stable long-run behavior. Even though the sample size of the regression is not impressively large (16 countries), the result is very robust. The estimated FH coefficient for the entire 15-year sample is 0.887 with the standard error of 0.07 (*Table 1*). Clearly, it is significantly different from zero but not from one. In sum, "the evidence strongly contradicts the hypothesis of perfect world capital mobility and

[1] Feldstein and Horioka emphasized the increase in savings caused by policy shock such as the tax cut because they initially aimed to investigate the ineffectiveness of such policies. However, the result is also true for other exogenous shocks such as purely stochastic shocks or preference changes.

indicates that most of any incremental saving tends to remain in the country in which saving is done" (Feldstein and Horioka, 1980, p.321).

In the follow-up paper, Feldstein (1983) extended the sample period over the Oil Crisis or to the end of the 1970s. Also, he modified (1) to express the relationship between the net foreign investment and savings (or the current account) and the domestic savings as:

$$\left(\frac{CA}{Y}\right)_i = -\alpha + \phi \left(\frac{S}{Y}\right)_i \qquad (2)$$

where $CA \equiv S-I$ = current account, and $\phi = (1-\beta)$. Again, if the capital is truly perfectly mobile, the ϕ should be zero. The result from Feldstein (1983) apparently reinforces the earlier findings. His FH coefficient is 0.865 over the 1975-79 period with the standard error of 0.185. In addition, the ϕ in (2) is estimated at 0.092 with the standard deviation of 0.785. The hypothesis of imperfect capital mobility cannot be rejected in both cases.

Table 1 Selected Supporting Empirical Results on FH Saving-Investment Relation

Study	FH coeff	(Std.err.) [t-stat]	R^2	Average	Sample Period	Sample Country
Feldstein-Horioka (1980)	0.887	(0.074)	0.91	15-yr	1960-1974	16 OECD
Feldstein (1983)	0.865	(0.185)	0.57	5-yr	1975-1979	17 OECD
Frankel (1985)	0.914	(0.238)	0.91	10-yr	1870-1979	U.S.
Dooley *et al.* (1987)	0.88	[5.47]	0.68	6-yr	1974-1981	19 Industrial
Tesar (1990)	0.85	(0.15)	0.59	12-yr	1975-1986	23 OECD
Obstfeld-Rogoff (1994)	0.662	(0.094)	0.69	10-yr	1982-1991	22 OECD
Blanchard-Giavazzi (2002)	0.57	Sig.	n/a	10-yr	1991-2001	OECD

A large body of literature soon follows the FH innovation. At the beginning, economists tried to re-estimate (1) with the hope to invalidate the FH conclusion, but all of them failed to do so and instead found supporting evidences for the FH conclusion.

Table 1 summarizes some of these efforts. The FH result has created nuisance among economists greatly because it contradicts the general belief that the capital market is increasingly integrated. After a certain amount of unsuccessful cross-examinations, the FH results are nominated to be one of the "puzzles" in the field of international economics. Along with other puzzles, the FH puzzle needs to be solved for a better understanding of the field. Explanation of why S-I are highly related is certainly required.

III. EXPLANATIONS

The controversial findings of FH (1980) and Feldstein (1983) have spawned an large amount of literature trying to explain why saving and investment rates appear to be correlated. Solving the FH puzzle has become another playground for economists. Admittedly, it is less than possible to review all literatures involved with the FH puzzle. Nonetheless, it is believed that major explanations of the S-I relationship have been covered in this paper. These explanations include endogeneity of S-I, international monetary regimes, heterogeneity of countries, government policies on external balance, and current account solvency. A short summary of recently developed explanations can also be found at the end of this section.

3.1 ENDOGENEITY OF SAVINGS AND INVESTMENT AND COMMON FACTORS

As Westphal (1983) pointed out, it is unlikely that the saving rate in (1) would be exogenously determined. In fact, the saving rate can be affected by the same factors that determine the investment. Thus, from the regression of (1), the error term—including the other factors that influence investment—will also be correlated with the left-hand side variable, the saving rate. The problem of dropping important variables in (1) can be severe and can cause the FH result to be biased.

In the search of common factors, the growth of population and the technology shocks seem to be the leading contenders. It can be shown that a simple life-cycle model can produce the population growth rate as a common factor influencing both saving and investment rates (Obstfeld, 1985). As a result, the two rates tend to move together even though they are not correlated (or even though the capital is perfectly mobile). For the illustrative purpose, let us consider a small open economy, in which consumers live for two periods. They work at the first period and are retired at the second. A representative consumer maximizes his lifetime utility, while firm produces outputs at the given prices and interest rate. Their problems are:

$$\underset{C_t, C_{t+1}}{Max} \;\; u(C_t) + \beta \, u(C_{t+1}) \quad subject \; to \quad C_t + \frac{C_{t+1}}{(1+r^*)} \le w \tag{3}$$

$$\underset{K_t, L_t}{Max} \;\; F(K_t, L_t) - (r^* + \delta) \;\, K_t - w \; L_t \tag{4}$$

where $u(\bullet)$ = felicity utility function, C_t = consumption in period t, β = rate of time preference, $F(\bullet)$ = production function, K_t = capital, L_t = Labor, r^* = world interest rate, δ = depreciation rate, and w = wage. It is assumed that $u(\bullet)$ take the logarithmic form, β is equal to $1/(1+r^*)$, and the production function takes the Cobb-Douglas form with constant return to scale. The key assumption is that population grows at rate n. Let us denote the capital share of output as α. This problem can be easily solved for equilibrium levels of consumption, capital, and output. Then, saving is merely the difference between output and consumption, and investment is the difference of capital between two adjacent periods. At the equilibrium, the savings per output would be $n(1- \alpha)/[(1+n)(2+r^*)]$, and the investment per output is $n\alpha/(r^*+\delta)$. Clearly, both are increasing in n. From this result, it can be concluded that countries' saving and investment rates can be correlated even though the capital is perfectly mobile. Thus, the FH conclusion is flawed in the way that the common factors (the population growth in this case) are not taken into account. Obstfeld points out that the S-I relationship occurs because of the immobility of labor rather than of capital. The other important common factor is the technology shocks. A similar model can be constructed by including technology in the production function.[2] The implication would not be largely different.

Though, in his 1985 paper, Obstfeld tries to prove this hypothesis by using simulation technique, this argument has found little support from other empirical studies. In their original paper, FH are already aware of this problem. One of the several extensions of (1) conducted by FH is the inclusion of population growth. They report that the coefficient of the population growth is "very small and statistically quite insignificant" (Feldstein-Horioka, 1980, p.322). Emphasizing the endogeneity problem of S-I, Frankel (1985) estimates (1) using, instead of S/Y, an instrumental variable constructed based on saving rates and population. He cannot reject the low capital mobility conclusion as well. Summers (1988) re-estimates (1) with population growth and economic growth on the right-hand side. His result shows that the coefficient of each new variable is only 0.002 and 0.0026 respectively, and none is significant.

The best support for the common factor hypothesis comes from Taylor (1994). Regressions of savings and investment on economic growth, age-structure, product of the two, and price level are conducted separately. Then, the error terms from both regressions (or the net-common-factors savings and investment) are tested as in (1). The result shows that the coefficient is far from unit and not significantly different from zero, which indicates that capital is perfectly mobile. However, because of the overwhelming

[2] Interested reader can consult Chapter 4 of Romer (2001) on the real business cycle.

evidences for the rejection of this hypothesis, a single evidence from regression on residuals would not be very convincing. Economists still consider this argument as lacking empirical support.

3.2 INTERNATIONAL MONETARY REGIMES

If one looks at the world history of international monetary economic, it is clear that the entire history is not dominated by one particular exchange rate regime. Different regimes emerge at different points in time. The level of financial market integration would certainly be affected by the concurrent regime. For example, during the gold standard regime that characterized economies during the end of 19^{th} century and the early 20^{th} century, the capital was highly mobile because of the low exchange rate risk. Then, the high level of capital mobility was marred during the interwar period from 1921 to 1944. After the World War II, major countries reached the Bretton-Woods agreements of fixed but adjustable exchange rates. Despite of its good will, the Bretton-Woods regime actually led the world toward monetary instability and introduction of capital controls. Finally, after the "temporary" collapse of the agreement in 1973, most countries in the world has generally moved toward the liberalization of capital movements. A study by Taylor (2002) (to be discussed in detail in section IV) on the current account dynamics confirms this relationship between regimes and capital mobility. The values of FH coefficients are different for different sample periods. Therefore, it could be argued that the FH result, which is derived from the data during the Bretton-Woods system, actually reflects the true status of the capital mobility at the time. Other studies that find different FH coefficients under different regimes—especially between the Bretton Woods and the post Oil Crises—include, for instance, Corbin (2001) and Ozman (2003).

However, this argument is not sufficient in itself. First, many studies that use data during the post Oil Crisis period, during which capital is generally believed to be highly mobile, still cannot reject the null hypothesis of imperfect mobility. Moreover, the hypothesis can only explain why the S-I relationship differs across time but does not answer the true puzzle of why they are related. Nonetheless, this argument is not completely useless. It gives rise to the concern over the sample period being studied in most, if not all, of the following literature.

3.3 Heterogeneity of Countries I: Big vs. Small

One of the assumptions needed to hypothesize that savings and investment should not be related under the perfect capital mobility is the small country assumption. Countries must be small enough to have no effect on the world interest rate. If not, an increase in saving in a "big" country may as well reduce the world interest rates. This will, in turn, affect investment in all countries and will reduce the outflow of the additional savings. Nevertheless, the early literatures struggled to support this hypothesis. Correction for the bias owing to country size made by Fieleke (1982) still leaves a significant correlation between savings and investment.

The most obvious example of the "big" country is the United States. Clearly, the U.S. is not a small country both in terms of its actual size and its role in the world financial market. Further, the U.S. is believed to be highly integrated with other capital markets, implying that its FH coefficient should be very low. In contrast, the study by Frankel (1985) shows that the FH coefficient of the U.S. is as high as 0.914 over the period from 1870 to 1979. This high coefficient, according to FH, suggests that the U.S. is rather isolated from the world financial market. It is true that a drop in domestic savings in the U.S. would seem to be offset by the capital inflows from the rest of the world (Mann, 2002). However, the evidence discussed in detail by Frankel shows that the inflows are not enough to prevent the U.S. interest rates from rising and crowding out the investment. This is because when the U.S. interest rate falls, the world interest rate is likely to fall too. The world savings then decline, and less capital flows into the U.S. As a result, the FH coefficient of the U.S. can be close to unity, even though its financial market is highly integrated with the world.

On the other hand, one can look at “small” country case and observe whether the estimated FH coefficient is high or low. Vamvakidis (1998) does so with 103 low- and middle-income non-OECD countries. These countries are “small” in the sense that changes in savings in an individual country have no impact on the world interest rate. Since these countries are less integrated to the world financial market than the U.S., their FH coefficient, according to FH, should be higher than the OECD or U.S. coefficient. In contrast, Vamvakidis finds the FH coefficient for the 103 non-OECD countries is only 0.014 (with 0.329 for middle-income sub-sample and -0.329 for low-income sub-sample).

A direct attack on the issue of country size can be found in Ho (2001) where a size variable measured in term of the relative individual country’s GNP to the total sample GNP is introduced in (1). Separating the sample into 3 sizes and employing the multiple thresholds model (two thresholds to be exact), Ho concludes that the hypothesis of equal coefficients of size variables among groups is clearly rejected. Large countries tend to have a larger level of investment. The more surprising result is that, after properly controlled for size, the FH coefficient of each group supports evidence found in Frankel (1985) and Vamvakidis (1998). Large countries have large value of FH coefficient, which should be an evidence for low level of capital mobility, and vice versa. The country size argument seems to fail find empirical supports as well as common factor hypothesis. Even if the empirical results support the hypothesis, this argument also fails to explain why saving and investment rates are correlated.

3.4 Heterogeneity of Countries II: Country and Currency Premium

The country-size argument seems to be too specific for the heterogeneity of countries. There can be numerous reasons for the heterogeneity. It is, however, difficult to spell out all of these affects, but Frankel (1993) argues that they should reflect in either "country premium" or "currency premium" of the country. A decomposition of real interest differential would help clarifying this argument. The real interest differential is:

$$r - r^* = (i - \Delta p^e) - (i^* - \Delta p^{e*}) = (i - i^* - fd) + (fd - \Delta p^e + \Delta p^{e*}) \qquad (5)$$

where r = real interest rate, i = nominal interest rate, Δp^e = expected inflation, fd = forward discount on the domestic current, and * denotes foreign rates. The first term $(i - i^* - fd)$ is the well-known covered interest parity. It is sometimes called the "country premium" because it captures all barriers to integration of financial markets across national borders. The second term is the real forward discount or the "currency premium" because "it captures the differences in assets according to the currency in which they are denominated rather than in terms of the political jurisdiction in which they are issued" (Frankel, 1993, p.55). This currency premium can be decomposed further to:

$$fd - \Delta p^e + \Delta p^e = (fd - \Delta s^e) + (\Delta s^e - \Delta p^e + \Delta p^{e*}) \qquad (6)$$

where Δs^e = change in exchange rate expectation. The two terms on the right-hand side of (6) are the exchange risk premium and the relative purchasing power parity (or expected real depreciation), respectively.

Under the FH claim of perfect capital mobility, it is required that this real interest difference must be zero. Any positive or negative difference must be arbitraged away. As pointed out by Frankel (1985, 1993), it is unlikely that all conditions in (5) and (6) would hold in reality. Although the increasing level of financial market integration would reduce the country premium largely, the currency premium tends to exist still. Evidences strongly suggest that the relative purchasing power parity does not hold (see for example Dornbusch, 1987, or Goldberg and Knetter, 1997). Thus, the FH condition for the financial integration can be expected to fail in general, and the high level of FH coefficient cannot imply low capital mobility.

To prove this point indirectly, some researchers turn to regional data in believing that there is no currency premium between regions within a county. Based on the U.S. regional data, Sinn (1992) finds an insignificant relation between savings and investment. Bayoumi and Rose (1993) utilize British regional data and find no correlation between savings and investment as well. On the extreme, Yamori (1995) concludes that the regional FH coefficient in Japan is negative and significantly different from zero. All of these evidences may support the conclusion that the violation of currency premium causes a rejection of FH financial integration condition. Unfortunately, empirical study that directly relates S-I relationship and country and current premium are not known to the author.

There is, however, a tangible amount of research trying to prove heterogeneity of countries without indicating the cause of heterogeneity. For example, Corbin (2001) allows for country-specific intercepts but impose a common slope coefficient. She finds that the estimated FH coefficient is much lower than the original FH coefficient and that the hypothesis of the existence of a fixed specific effect cannot be rejected. Coakley, Fuertes and Spagnolo (2001) extend Corbin's result by further allowing for different slopes. Then, they draw a conclusion from the mean group estimator[3]. The estimated mean group coefficient is only 0.33, and the hypothesis of perfect capital mobility cannot be rejected as well.

3.5 GOVERNMENT POLICIES ON EXTERNAL BALANCE

Since the internal balance is not the only goal of the government, a persistently large external deficit can possibly create a pressure on the government to correct such deficit. Countries consistently manipulate the economic policies with a view to maintain external balance. These policies may be varied from the exchange rate regime switching, fiscal policies, or regulations on capital flows. The history of international trade suggests many more measures that can be carried out such as the "voluntary" export restraint on the trading partners. Thus, even though capital is actually perfectly mobile, it may appear immobile "only because countries pursue policies that bring savings and investment into balance" (Summers, 1988, p.369). The advocates of this maintained external balance hypothesis include, for instance, Tobin (1983), Summers (1988), Tesar (1991), and Ozman (2003). Further, Summers argues that this maintained external balance hypothesis can explain why developing countries appear to have lower FH coefficient. It is because the pressure to maintain external balance is much weaker, and so the actions are not needed to prevent capital flows.

[3] In simple words, it is the mean of coefficients received from individual country time-series regression. The estimators is believed to provide a measure of the average long run saving-investment association better than the estimators received from cross-sectional data as suggested by Feldstein-Horioka.

Although there are many policy options to correct the external imbalance, most of the literatures focus specifically on the fiscal policy. The government in a country with large external deficit may decide to increase taxes or reduce its expenditures in order to alleviate the imbalance. Each of these actions tends to increase the government savings and therefore the domestic savings. As a result, this hypothesis is sometimes called the "endogenous fiscal policy" (Miller, 2002).

In fact, the existence of budget deficit is already enough to contaminate the S-I relationship. As Roubini (1988) points out, the traditional S-I regressions are incorrect because they do not control for the independent role of budget deficits. To illustrate this point, Roubini constructs a model with consumption smoothing and tax smoothing. The model is similar to (3) and (4) but in an infinite horizon fashion. Government exists in this model, and individuals need to pay lump-sum taxes. The government's objective is to minimize distortionary effects of income tax as:

$$Min \sum_{j=0}^{\infty}(1+r)^{-j} D(\tau_{t+j})\ Y_{t+j} \ subject\ to \sum_{j=0}^{\infty}(1+r)^{-j} G_{t+j} \leq \sum_{j=0}^{\infty}(1+r)^{-j} T_{t+j} - (1+r)B^{g}{}_{t-1} \quad (7)$$

where τ_t = income tax rate, $D(\bullet)$ = distortion effects of income taxation, and B^g = public debt. If one makes assumptions on the functional forms and the rate of time preference and defines a permanent value of a variable as $\widetilde{X} = \Sigma(1 + r)^{-j} X$, one can derive:

$$CA_t = -DEF_t + (1-\tau_t)(Y_t + \widetilde{Y}) - I_t \quad (8)$$

where DEF_t = government budget deficit at time t. Equation (8) is actually similar to (2), but the difference is the government budget deficit. Then, using the current account identity, a testable equation can be derived from (8) as:

$$S_t = \alpha_0 DEF_t + \alpha_1(Y_t - \widetilde{Y}) + \alpha_2 I_t \quad (9)$$

Equation (9) is also similar to (1), and the α_2 is similar to the FH coefficient when controlled for the budget deficit. The hypothesis of capital mobility, smoothing consumption and smoothing taxation would implies that $\alpha_0 = -1$, $\alpha_1 = (1-\tau_t)$, and $\alpha_2 = 0$. The results from 18 OECD countries suggest that the α_0 is significantly different from zero but not from negative one in most cases. The more important result is that the α_2 is now either insignificant or significant but less than zero. Only 5 out of 18 countries have α_2 not different from one (the case of capital immobility). This suggests that the FH result is incorrect because they do not control for the independent role of budget deficit.

3.6 CURRENT ACCOUNT SOLVENCY

The current account solvency argument is developed from the maintained external balance hypothesis previously mentioned. This hypothesis, however, does not require manipulative actions made by the government *per se*. It only needs the no-Ponzi-game condition or the intertemporal budget constraint to hold. The idea is that a country cannot roll its debts forever. At some point, it must repay its previous borrowings, and the current account would move toward the balance level. Recent developments in econometrics have helped verifying this argument immensely. In econometric terms, the current account solvency would be referred to as the stationarity of current account. Thus, from the current account identity ($CA=S-I$), if the current account is an I(0) process, savings and investment must be cointegrated of order one. If, however, the savings and investment were random walks, the balance of payments would be nonstationary and foreign debt would be unbounded.

An interesting paper by Jansen (1996) shows that the unit FH coefficient can be generated even if there is no direct short-run relationship between S-I in level. The only condition required is the cointegration between the two variables. The technique of Monte Carlo simulations is employed to support this claim. First, saving and investment rates need to be simulated from the following two equations.

$$SR_{i,t} = SR_{i,t-1} + \varepsilon^{S}_{i,t} \tag{10}$$

$$\Delta IR_{i,t} = \alpha_i \gamma + \phi\, \Delta SR_{i,t} + \gamma (SR_{i,t-1} - IR_{i,t-1}) + \varepsilon^{I}_{i,t} \tag{11}$$

where $SR_{i,t}$ = saving rate in country i at time t, and $IR_{i,t}$ = investment rate. The saving rate is thought to be a random walk without a drift and does not depend on investment, while the investment follows the error correction model (ECM) where cointegration between saving and investment is assumed (when $\gamma \neq 0$). For given values of γ and ϕ, saving and investment rates are then generated and are used to estimate coefficients in (1). This process is then iterated 1,000 times to find the expected value and variance of the FH coefficient. The result suggests that the larger values of γ, the FH coefficient will be closer to one and its variance will be smaller. From this result, Jansen concludes that the high S-I correlation found in cross-section studies only reflects the cointegration of each country's S-I over the time but not the capital immobility as suggested by FH. This hypothesis also explains why Frankel (1985)'s estimated FH coefficient are as high as 0.914 for the U.S. (as shown in *Table 1*). It should be believed that the current account stationarity would hold, and the S-I are highly cointegrated during such a long period.

However, based on the real data, testing for I(1) process of savings and investment seems to be easier than testing for the cointegration between the two. Taylor (1996), on one hand, investigates the cointegration between savings and investment in 12 countries based on the ECM as (9). His findings indicate that the hypothesis of zero γ, cointegrating vector, can clearly be rejected. Coakley, Kulasi and Smith (1996), on the other hand, find that even though the unit root hypotheses of saving and investment are easily rejected, only 3 out of 23 OECD countries reveal the cointegration between S-I based on the Johansen tests. It is known that the cointegration tests are delicate and often give conflicting results. This leads to the conclusion that "the evidence of cointegration is weak or mixed" (Coakley *et al*., 2001, p.2)

3.7 OTHER EXPLANATIONS

Our six explanations are still far from a complete list of explanations for the FH puzzle. However, due to our page constraint, we decided not to discuss the following explanations either because they have already been rejected or because we find no empirical evidence related to the explanations. The hypotheses mentioned in the past include the immobility of capital (Summers, 1988), the capital sufficiency of developed countries (Summers, 1988), the transitional dynamics of a country toward its steady state (Taylor, 1994), or the substitutability of domestic and external savings (Sachsida and Caetano, 2000). More recently, explanations are based on the transportation costs (Obstfeld and Rogoff, 2000) and investment risk (Ventura, 2002). It is noted that the effort by Obstfeld and Rogoff (2000) that tries to explain six major puzzles by only one cause, can possibly spur another round of literature attempting to do the similar thing with another cause or on more puzzles. Therefore, we can expect to see even more explanations for the FH puzzle in the future.

IV. ALTERNATIVE CAPITAL MOBILITY MEASUREMENTS

Many explanations of the FH puzzle strongly suggests that the high S-I correlation does not imply the imperfect capital mobility. It is therefore important for economists to come up with an alternative measure for the level of capital mobility.

However, a substantially less amount of research has tried to do so than to solve the puzzle. We will discuss here 3 alternatives proposed by Obstfeld, Ghosh, and Taylor.

Obstfeld (1986) stresses the role of marginal rate of substitution between consumption on different dates. He argues that if consumers of different countries have access to the same nominally risk-free bond, the expected marginal rate of substitution between consumption on different dates should be equal for all countries. Starting from an infinite-horizon version of (3), he solves for the Euler's equations for home and foreign countries. The Euler's equations certainly depend on the interest rates, which can be substituted for the common risk-free interest rate in both countries. Suppose that the risk-free rate is denominated in home currency. The Euler's equations of the foreign can be subtracted from the equation of home country, and the result would be:

$$E_t\left[\frac{P_t}{P_{t+1}}\left(\frac{C_t}{C_{t+1}}\right)^{\alpha} - \left(\frac{s_t P_t^*}{s_{t+1} P_{t+1}^*}\right)\left(\frac{C_t^*}{C_{t+1}^*}\right)^{\alpha}\right] = 0 \qquad (12)$$

where i_t = risk-free rate, s_t = exchange rate, and α = elasticity of consumption. Equation (12) can be rewritten as $E_t(\eta_t) = 0$ where η_t is a function of known variables and assumable parameter, which can be constructed using the real data and assumption on the parameter. After constructing η_t, we have the following testable equation.

$$\eta_t = \gamma_0 + \sum_{i=1}^{N} \gamma_i \, \eta_{t-i} + \varepsilon_t \qquad (14)$$

The hypothesis of perfect capital mobility would be true when the marginal rates of substitution are equal for all countries or when $\gamma_0 = \gamma_1 = \ldots = \gamma_N = 0$. This strongly micro-founded test seems to be too cumbersome in practice. When applied to many countries, this pairwise test would increase the workload substantially. Obstfeld points out a few caveats of this method such as the durable goods in consumption that could distort the equality of marginal rates of substitution between countries.

Another alternative based on the variance of the current account is suggested by Ghosh (1995). If the capital is perfectly mobile, people should be able to borrow to smooth consumption when they face unanticipated changes. The variance of current account should be "large" as a result. The problem boils down to the setting up a benchmark to decide how large of the variance is actually "large". Applying the intertemporal approach (similar to an infinite-horizon of (3)), Ghosh derives the optimal consumption, which can be decomposed into 2 parts—consumption smoothing and consumption tilting. A country may tilt consumption toward present or future depending on the discount rate and interest rate, but it smoothes consumption in the face of shocks. Intuitively, we can use only the consumption smoothing part to construct the optimal consumption-smoothing current account, CA_t*. In practice, Ghosh uses the Vector Autoregressive model (VAR) to construct CA_t* and uses its variance as the benchmark. He concludes that the U.S. has low capital mobility, while Japan, Germany, U.K. and Canada have "excessive" capital mobility. Although the concept of this test is reasonable, it would again find it very difficult in practice, especially in estimating the unknown CA_t*.

The last alternative comes from Taylor (2002), whose supposition is based on the dynamics of current account. He implements the simple AR(1) regression of the form in (15) below and investigates the value of β. He argues that β is the speed of convergence. If β is smaller in absolute term, the country must have a more flexible current account and the higher capacity to run persistent deficits (or surplus) than others.

$$\Delta(CA/Y)_t = \alpha + \beta(CA/Y)_{t-1} + \varepsilon_t \qquad (15)$$

His estimated β for a group of 15 countries are −0.34 during the Gold Standard, −0.41 during the interwar period, −0.74 during the Bretton-Woods system, and −0.32 for the post-Oil Crisis period. The result seems to be consistent with the general pattern of the world capital mobility. Certainly, this test for perfect capital mobility would be comfortable to conduct, but it is not very convincing that slow speed of adjustment would entirely mean the high capital mobility. Instead, the slow speed may be a result of other factors such as the closeness of an economy to its steady state, the change in composition of borrowing maturity, etc.

V. CONCLUSIONS AND SUGGESTIONS

In 1980, Feldstein and Horioka introduced their findings on the relationship between saving and investment rates, which turns out to be a major obstacle to the conclusion of perfect capital mobility. Since then, there has been a large body of literatures attempting to solve the puzzle. The explanations of the FH puzzle have gone in many directions including common factors, exchange rate regimes, heterogeneity of countries, government policies, etc. Some of these attempts may be very convincing but happen to be empirically inadequate. Others may have strong empirical supports but cannot explain why the FH coefficients differ across time or country. Although the explanation of the puzzle is not yet clear and concrete, economists appear to form a consensus about this puzzle already. In fact, all of the explanations mentioned above try to make the same argument that the FH coefficient close to one does not necessarily imply the imperfect capital mobility. Repeatedly, theoretical explanations have shown that S-I correlation may occur even if they are not truly related and the capital is perfectly mobile.

Some economists still incline to use the FH coefficient as a proxy for financial openness, for example, Blanchard and Giavazzi (2002). This must be done with caution. As suggested above, the absolute value of FH coefficient does not mean anything, but one may use it to compare with the estimator from different sample period within the same sample countries. As seen in *Table 1*, the FH coefficients seem to be declining for the OECD sample, which suggests higher capital mobility for this sample. Unless a new reliable measure for capital mobility is proposed, we still can use the FH condition only for this purpose and with extreme cautions.

If the FH condition for perfect capital mobility seems to be incorrect, should we totally ignore the puzzle and move on with our lives? The answer is, of course, no. Although it is generally believed that the FH conclusion is not true, we are still far away from having a good explanation of why it is not true. The recent development in current account solvency explanation seems to come close of being the key answer of the puzzle, but it has not yet received a general agreement. It still fails to find empirical supports sometimes, but at least not most of the time. Even though we have learned a great deal about the S-I relationship for the past two decades, the puzzle still goes on.

References

Bayoumi, T.A. and A.K. Rose. 1993. "Domestic Savings and Intra-National Capital Flows." *European Economic Review*, 37, pp. 1197-1202.

Blanchard, O. and F. Giavazzi. 2002. "Current Account Deficits in the Euro Area. The End of Feldstein-Horioka Puzzle?" *Brookings Paper on Economic Activity*, 2002-2, pp. 147-209.

Coakley, J., A. Fuertes, and F. Spagnolo. 2001. "The Feldstein-Horioka Puzzle Is Not as Bad as You Think." Birkbeck College Discussion Paper no.10/2001, University of London.

_________, F. Kulasi, and R. Smith. 1996. "Current Account Solvency and the Feldstein-Horioka Puzzle." *The Economic Journal*, 106: 436, pp. 620-627.

Corbin, A. 2001. "Country Specific Effect in the Feldstein-Horioka Paradox: A Pannel Data Analysis." *Economics Letters*, 72, pp. 297-302.

Dooley, M., J. Frankel, and D.J. Mathieson. 1987. "International Capital Mobility: What Do Saving-Investment Correlations Tell Us?" International Monetary Fund, Staff Paper, 34:3, pp. 503-530.

Dornbusch, R. 1987. "Purchasing Power Parity," in *The New Palgrave Dictionary of Economics*. J. Eatwell *et al*. ed. New York: Stockton Press.

Feldstein, M. 1983. "Domestic Saving and International Capital Movement in the Long Run and the Short Run." *European Economic Review*, 21, pp. 129-151.

_________ and C. Horioka. 1980. "Domestic Saving and International Capital Flows." *The Economic Journal*, 90:358, pp. 314-329.

Fieleke, N.S. 1982. "National Saving and International Investment", in *Saving and Government Policy*. Conference Series no.25, Federal Reserve Bank of Boston, Boston.

Frankel, J.A. 1985. "International Capital Mobility and Crowding Out in the U.S. Economy: Imperfect Integration of Financial Markets or of Goods Markets?" National Bureau of Economic Research, Working Paper no.1773.

_________ 1993. "Quantifying International Capital Mobility in the 1980's.", in *On Exchange Rates*. London: MIT Press.

Ghosh, A.R. 1995. "International Capital Mobility Amongst the Major Industrial Countries: Too Little or Too Much?" *The Economic Journal*, 105:428, pp.107-128.

Goldberg, P. and M. Knetter. 1997. "Goods Prices and Exchange Rates: What Have We Learned?" *Journal of Economic Literature*, 31, pp. 1243-1272.

Ho, T. 2003. "The Saving-Retention Coefficient and Country-Size: The Feldstein-Horioka Puzzle Reconsidered." *Journal of Macroeconomics*, 25, pp. 387-396.

Jansen, W.J. 1996. "The Feldstein-Horioka Test of International Capital Mobility: Is It Feasible?" International Monetary Fund, WP/96/100-EA.

Mann, C.L. 2002. "Perspectives on the U.S. Current Account Deficit and Sustainability." *Journal of Economic Perspective*, 16:3, pp. 131-152.

Miller, N.C. 2002. "An Infinite Horizon Intertemporal Model." in *Balance of Payments and Exchange Rate Theories*. Edward Elgar Publishing: Massachusetts.

Obstfeld, M. 1985. "Capital Mobility in the World Economy: Theory and Practice." National Bureau of Economic Research, Working Paper no.1692.

_________ 1986. "How Integrated Are World Capital Markets?: Some New Tests" National Bureau of Economic Research, Working Paper no.2075.

_________ and K. Rogoff. 1994. "The Intertemporal Approach to the Current Account" National Bureau of Economic Research, Working Paper no.4893.

_________ and K. Rogoff. 2000. "The Six Major Puzzles in International Macroeconomics: Is There A Common Cause?" National Bureau of Economic Research, Working Paper no.777.

Ozman, E. 2003. "Policy Regime Change and the Feldstein-Horioka Puzzle: the UK Evidence." *Journal of Policy Modeling*, 25, pp. 137-149.

Romer, D. 2001. "Advanced Macroeconomics." Second Edition, McGraw-Hill.

Roubini, N. 1988. "Current Account and Budget Deficits in An Intertemporal Model of Consumption and Taxation Smoothing: A Solution to the Feldstein-Horioka Puzzle?" National Bureau of Economic Research, Working Paper no.2773.

Sachsida, A. and M.A. Caetano. 2000. "The Feldstein-Horioka Puzzle Revisited." *Economic Letters*, 68, pp.85-88.

Sinn, S. 1992. "Saving-Investment Correlations and Capital Mobility: On the Evidence from Annual Data." *The Economic Journal*, 102, pp. 1162-1170.

Summers, L.H. 1988. "Tax Policy and International Competitiveness", in *International Aspects of Fiscal Policies*. J. Frankel, ed. NBER Conference Report, Chicago: Chicago University Press.

Taylor, A.M. 1994. "Domestic Saving and International Capital Flows Reconsidered." National Bureau of Economic Research, Working Paper no.4892.

_________ 1996. "International Capital Mobility in History: The Saving-Investment Relationship." National Bureau of Economic Research, Working Paper no.5743.

_________ 2002. "A Century of Current Account Dynamics", National Bureau of Economic Research, Working Paper no.8927.

Tesar, L.T. 1991. "Savings, Investment and International Capital Flows", *Journal of International Economics*, 31, pp. 55-78.

Tobin, J. 1983. "Comments on Domestic Saving and International Capital Movements in the Long Run and the Short Run", *European Economic Review*, 21, pp. 153-156.

Vamvakidis, A. and R. Wacziarg. 1998. "Developing Countries and the Feldstein-Horioka Puzzle." International Monetary Fund, Working Paper no.WP/98/2.

Ventura, J. 2002. "Towards A Theory of Current Accounts." National Bureau of Economic Research, Working Paper no.9163.

Westphal, U. 1983. "Comments on Domestic Saving and International Capital Movements in the Long Run and in the Short Run." *European Economic Review*, 21, pp. 157-159.

Yamori, N. 1995. "The Relationship between Domestic Savings and Investment: The Feldstein-Horioka Test Using Japanese Regional Data." *Economics Letters*, 48, pp. 361-366.