INTERNATIONAL CAPITAL MOBILITY AND THE FELDSTEIN-HORIOKA PUZZLE: AN EMPIRICAL EXAMINATION FOR THE G5 NATIONS

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ABSTRACT

One of the major controversies in the area of "Open Economy Macroeconomics" is the continued use of the Feldstein-Horioka savings-investment (S/I) correlation. Despite many criticism and results to the contrary, it is still used as a standard measure of the level of international capital mobility. The extant volume of work on this topic is far from conclusive, and here we will re-examine the hypothesis with a different empirical procedure. We concentrate on the G5 nations, USA, UK, France, Germany and Japan. This study covers the time period from approximately 1955 to 2008. We examine the S/I index for the entire post WWII period, using the Hansen –Seo threshold cointegration methodology. ***JEL Classification:*** F41

INTRODUCTION

Stated in simple terms the Feldstein-Horioka (1980, FH hereafter) hypothesis tests the relationship between the national investment and the national savings rate. In basic econometric modeling terms, it runs a regression of national investment on national savings, and examines their correlation coefficient, called β. The value of β lies between 0 and 1. If β=1, it means a 100% correlation between the national investment and national savings rate. This is absolute financial autarky, meaning there is no foreign capital being invested domestically, i.e., capital mobility is zero. On the other extreme if β=0, then the domestic investment is completely financed by foreign capital, indicating perfect capital mobility. The general contention is that with opening of international capital markets, β should decrease over time. This principle has been tested across time series and cross sectional data using a plethora of tests, starting with simple regressions, all the way to using state of the art panel cointegration techniques. But the literature as of today has not come up with any conclusive results which hold up across time and space and choice of statistical techniques. Hence it is still a hot and contentious issue among researchers, and a topic of debate among policy makers.

The F-H hypothesis states that a high positive correlation between domestic investment (I) and domestic saving (S) would imply low international capital mobility. This means that domestic savings are being translated into domestic investments, with very little of the international capital component. They contended that if the domestic S and I (both expressed as a ratio of GDP) were cointegrated, that would imply low capital mobility amongst countries. For every country the dictum

"our money finances our investment" would be true. There is ample empirical evidence to suggest a high positive correlation between I and S.

Now for closed economies (autarkies) this may be true, but it need not be so for open economies where international capital could be an alternative conduit to finance domestic investment. This should be true to a large extent since in the last quarter century capital has become very mobile, especially among similarly situated (economically, politically, culturally socially etc.) developed countries.

Real world experience suggests that in today's electronic world where information dissemination is instantaneous and money transfer (even in bulk) can be done within seconds and at low transaction costs, it should be possible to raise money from international capital markets where the cost of capital is the lowest. But empirical evidence still suggests a high S/I ratio, especially among the developed economies, like the OECD countries and the European Union. So why would empirical evidence still point to a high S/I correlation and hence low capital mobility? This begs the question "is this an indicator of low capital mobility or is the F-H hypothesis not a good indicator of capital mobility?"

The results from the extant literature are across the board. There seems to be a conceptual contradiction alive and kicking. There is no reason for capital not to be mobile among developed economies. They are all stable economies and informational efficiency is at its highest level ever with instantaneous electronic transfers. Hence Obstfeld and Rogoff (2000) identify this as one of the six major puzzles in the area of international macroeconomics.

This topic is highly researched because academics / researchers / practioner's are not able to reconcile the conflicting evidence between high domestic S/I ratios and the highly efficient international capital markets out there, use of which should indicate high capital mobility. Since the literature is far from unanimous on this topic, we wanted to revisit this controversy with a different and robust econometric procedure and in the process possibly shed some additional light.

We propose to analyze the S/Y and I/Y ratios using the Hansen-Seo (2002) threshold cointegration technique for USA, UK, France, Germany and Japan, and use savings, investment and GDP data for each country. We believe this should help shed some additional light on the relationship between these ratios.

The outline of this study goes along these lines. Section 2 does an extensive literature review and also discusses the possible reasons for the differences in outcome in this topic. Section 3 has a short description of the Hansen-Seo (2002) methodology, with our results in section 4. This is followed by our concluding remarks.

LITERATURE REVIEW

The seminal study in this topic was the F-H (1980) paper which correlated the domestic S/I relationship with international capital mobility. In their 1980 study they looked at 16 OECD countries data in a cross sectional set up for the period 1960–74. They estimated the following regression:

$$(I/Y) = \alpha + \beta(S/Y) + \mu \qquad (1)$$

where S/Y is the savings GDP ratio, I/Y is the investment GDP ratio, β is the saving-retention coefficient and μ the error term. The F-H correlation is based on the

economic rationale that high capital mobility would imply low conversion of domestic savings into domestic investment, since savers would be facing the same world interest rates and therefore could invest anywhere in the world. But conversely if capital mobility is low, that will drive a wedge between domestic and foreign borrowing costs and domestic investment will be financed by domestic saving. Based on eq.1, F-H found β, the saving-retention coefficient, to be "not significantly different from 1" indicating low capital mobility. This is so because β is measured as the proportion of incremental saving invested domestically. If international capital mobility is perfect, β would be close to zero.

They found a β of 0.88, which implied high correlation between domestic saving and domestic investment for all the countries, and hence low international capital mobility. Thus very little home investment is financed by foreign money, i.e., international capital mobility is very low. It may be because borrowers have a home country bias (when deciding the source of their funding) which is indeed an accepted norm in international economics. But with increasing allocative efficiency and lowering of per unit transaction costs, capital should be more and more mobile over time. But for this to be true the regression coefficient i.e., β value should support this claim based on the results from the EURO zone. Feldstein extended the same study up-to 1980 in his 1983 paper, and found similar results.

The disconcerting fact was that at the same time there was evidence of the world capital markets getting more and more deregulated, with increasing purchasing power parity and capital allocation being made based on interest rate differentials among economies. There was ample evidence of increasing capital mobility among countries, especially among the developed countries, OECD countries, and the European Union. So why would empirical evidence still point to a high S/I correlation and hence low capital mobility? Hence it was dubbed a puzzle.

Dooley, Frankel and Mathiesen (1987) found results consistent with the original F-H study. Coakley, Fuertes and Spagnolo (2003) also find a high S/I correlation, implying low capital mobility. Adey (2003) tests the F-H hypothesis for 21 OECD and European Union countries for the period 1970 – 2000, and using a simultaneous equation model and panel estimation techniques they confirm the F-H hypothesis.

However, Bayoumi (1990) found indication of high capital mobility (rejection of F-H hypothesis) as evidenced through liberalization of domestic financial markets and dismantling of capital controls. Bebezuk and Schmidt-Hebbel (2006) use data from 16 OECD countries between 1973-2003, with sector level economic regression, done by breaking the country into household, corporation and government data. They find a β coefficient of 0.5, but once the sectoral coefficients are considered, β gets close to zero, implying a high degree of capital mobility. Caporale, Panopoulou and Pittis (2007) use 23 OECD countries data, and find little evidence supporting the F-H hypothesis. Brahmasrene and Jiranyakul (2009) and Murthy (2009) both conclude that there is high capital mobility (no F-H hypothesis) in their samples. Katsimi and Moutos (2009) examine the F-H hypothesis using a broader definition of capital by considering saving and investment in human capital. Using data for 25 OECD countries, they find evidence for increasing capital mobility since the 1960s. Some of the reasons put forward for the difference in the results (the puzzle) described above are:

(1) Cross sectional studies indicate results at a point in time, and so the effect of a transaction of S on I over time is difficult to derive. Gomes, Ferreira, and Filho

(2008) reach the conclusion that the constant parameter model (the assumption of a constant β in the F-H model, the savings retention rate, is misleading and time-varying model is a better fit. They also conclude that the savings-investment correlation is a misleading measure of capital mobility. Telatar, Telatar, and Bolatoglu (2007) state that the F-H relationship may be subject to regime change and should be modeled as a time-varying phenomenon.

(2) Some studies have tried to explain this puzzle by suggesting that the S/I correlation is not a good indicator of the degree of capital mobility, since they could be cointegrated even if capital were mobile. This could be because of large country effects, endogenous shocks etc. Again a borrowing country has to maintain its inter-temporal budget constraint, because it cannot borrow forever. In this case S/I will be cointegrated irrespective of the degree of capital mobility present. Work along these lines are Bayoumi (1990), Obstfeld and Rogoff (2000), Herwatz and Xu (2006), and Georgopolous and Hejazi (2009).

(3) Then we have Harberger (1980) and Murphy (1984) who argue that the size of the country would result in an endogeneity problem. For example if there is a drop in the savings rate in a large economy, it would lead to a rise in interest rates, and consequently a fall in investment in those countries. International capital mobility as we see has nothing to do with this correlation reasoning. Kollias, Mylonidais, and Paleologou (2008) come to the opposite conclusion using a autoregressive distributed lag procedure to look at the F-H hypothesis for the EU15 countries, and find evidence in favor of high, moderate and low capital mobility with no particular pattern in terms of country size or level of development.

(4) Another reasoning forwarded for this puzzle is the policy response argument proposed by Fieleke (1982) and Tobin (1983). They contend that the original F-H formulation in terms of eq.1 is misspecified, because governments try to reduce current account imbalances through fiscal policy, resulting in a S/I correlated structure.

(5) Another contention for having high S/I correlation and the simultaneous existence of high
capital mobility is due to missing variables. Bayoumi (1990) believes that this is due to the government's policy approach towards unanticipated shocks. Engel and Kletzer (1989) contend it is due to the existence of traded and non-traded goods. Once the government sector is excluded, the correlation strength drops significantly. Even when inventory investment is omitted, the same result happens.

(6) Another reasoning forwarded for the puzzle is the different time periods and the policy changes that have taken place over time. For example in the original F-H study, the time span was 1960-74, a period marked by high capital controls in many countries so low capital mobility seems logical. This idea of a regime shift is in line with the suggestions of Telatar, Telatar, and Bolatoglu (2007).

So there seems to be a conceptual contradiction alive and kicking. There is no reason for capital not to be mobile among developed economies. They are all stable economies and informational efficiency is at its highest level ever with instantaneous electronic transfers. Since the literature is far from unanimous on this topic, we wanted to revisit this controversy with a different approach. We propose to analyze the S/Y and I/Y ratios using the Hansen-Seo (2002) threshold cointegration technique for the United States, United Kingdom, Japan, France and Germany USA, and use savings, investment and GDP data for each country. We believe this should help shed some additional light on the relationship between these ratios.

HANSEN – SEO THRESHOLD COINTEGRATION MODEL

One of the explanations put forward for the lack of evidence in favor of the F-H hypothesis mentioned above is that the empirical model can change over time, i.e., a regime shift. This is particularly important during periods where policies have potentially changed and/or when there have been external shocks which could have led to a regime change. A robust econometric analysis will require the use of a econometric procedure that allows for a regime change (test of stability of the model). The Hansen-Seo procedure allows us to test for cointegration of variables and the existence of a threshold for a regime change at the same time. Since cointegration is itself a particularly suitable procedure for testing for co-movement of two variables (like investment and savings ratios as in the case of the F-H hypothesis) threshold cointegration as formulated in the Hansen-Seo procedure is particularly suitable for testing for the F-H hypothesis.

Threshold cointegration introduced by Balke and Fomby (1997) combines nonlinearity and cointegration by allowing for nonlinear adjustments over the long run. It begins by testing for the presence of a bound or threshold where the null hypothesis is of linearity. Hansen –Seo (2002) extend the Balke and Fomby (1997) and the Lo and Zivot (2001) test to examine for the presence of an unknown cointegrating vector. Under the null hypothesis of no threshold it reduces to a linear VECM. They apply the Lagrange multiplier (LM) test for threshold cointegration and calculate the p-values. Simulation evidence is provided to justify the size and the power of the tests. The basic model is:

$$\Delta x_t = A' X_{t-1}(\beta) + u_t$$

where x_t is a p-dimensional I (1) time series which is cointegrated with one $p \times 1$ cointegrating vector β. $w_t(\beta) = \beta' x_t$ is the I(0) error-correction term We can write a linear VECM as

$$X_{t-1}(\beta) = \begin{pmatrix} 1 \\ w_{t-1}(\beta) \\ \Delta x_{t-1} \\ \vdots \\ \Delta x_{t-l} \end{pmatrix}$$

A is $k \times p$, where k = pl + 2. The error u_t is assumed to be a vector martingale series with finite covariance matrix $\Sigma = E[uu']$. At the true value of β both the left and the right side of the equation is I(0). A two regime threshold model takes the following form

$$\Delta x_t = \begin{cases} A'_1 X_{t-1}(\beta) + u_t & \text{if} \quad w_{t-1}(\beta) \le \gamma \\ A'_2 X_{t-1}(\beta) + u_t & \text{if} \quad w_{t-1}(\beta) > \gamma \end{cases}$$

The regime is determined by the size of the error correction term. We could also write this as

$$\Delta x_t = A'_1 X_{t-1}(\beta) d_{1t}(\beta,\gamma) + A'_2 X_{t-1}(\beta) d_{2t}(\beta,\gamma) + u_t$$

where

$$d_{1t}(\beta,\gamma) = 1(w_{t-1}(\beta) \le \gamma)$$

$$d_{2t}(\beta,\gamma) = 1(w_{t-1}(\beta) > \gamma)$$

are indicator functions. They undertake a grid search based on a prior linear and consistent estimate of the cointegrating vector β. The search is conducted for the values of [β, γ] over the range [β_L and β_U] and [$\gamma_{L \text{ and }} \gamma_U$]. The threshold test is for H_0 (null hypothesis of linear cointegration) versus H_1 (alternative hypothesis of threshold cointegration)

EMPIRICAL RESULTS

We estimate and test models of cointegration for the United States, United Kingdom, Japan, France and Germany using the saving/GDP and Investment/GDP ratios. All data was obtained from the OECD National Accounts database. All data is quarterly. Data for United States and the United Kingdom is from 1955 quarter 1 to 2008 quarter 4. Data for France, Germany and Japan is from 1960 quarter 1 to 2008 quarter 4.

The S/Y and I/Y ratios for each of the countries are tested for the presence of unit roots, and all series are found to have unit roots (the results are not included in the paper as these are standard results). We then proceed to estimate and test models of cointegration using the S/Y and I/Y ratios. First we run the conventional Engle-Granger (1987) test of bivariate cointegration (to reject the null hypothesis of no cointegration). Then based on these results we examine for threshold cointegration between the S/Y and I/Y ratios. For each country, the Engle-Granger test rejects the null hypothesis of no (linear) cointegration, implying that the S/Y and I/Y ratios are cointegrated. We then proceed to test for the existence of threshold cointegration using the Hansen-Seo procedure, which is a test of the null hypothesis of linear cointegration against the alternate hypothesis of threshold cointegration..

Table 1
S/Y AND I/Y: TESTS FOR THRESHOLD COINTEGRATION (P-VALUES)

	Bivariate	
	β=1	**β estimated**
France	0.0024	0.042
Germany	0.273	0.1464
Japan	0.8224	0.5366
United Kingdom	0.0064	0.2448
United States	0.1346	0.1410
	Univariate	
	β=1	**β estimated**
France	0.0464	0.03
Germany	0.4458	0.8202
Japan	0.2746	0.2922
United Kingdom	0.1704	0.5328
United States	0.6854	0.7996

NOTE: In testing for threshold cointegration, we use the SupLM test (estimated cointegration vector) and $SupLM^0$ test (cointegration coefficient = 1), with p-values calculated by bootstrap. For comparison, we also calculated the univariate Hansen (1996) TAR test.

First we tested for bivariate cointegration. In testing for threshold cointegration, we use the SupLM test (estimated cointegration vector) and $SupLM^0$ test (cointegration coefficient = 1), with p-values calculated by bootstrap. For comparison, we also calculated the univariate Hansen (1996) TAR test to the error correction term. The value of "l" (lag length) was determined by using the AIC and BIC criteria. The results seem to be fairly consistent, with a couple of exceptions. When β is estimated, there is evidence at the 5 percent level for threshold cointegration for France only. There is no evidence in favor of threshold cointegration for any of the other countries. This lack of co-movement between I/Y and S/y is a rejection of the F-H hypothesis, is in line with a lot of the recent literature in this field, like Caporale, Panopoulou and Pittis (2007), Brahmasrene and Jiranyakul (2009), Murthy (2009), and Katsimi and Moutos (2009).

When β is restricted to be equal to 1, there is still evidence in favor of threshold cointegration for France only and not for any of the other countries. The univariate tests also show evidence in favor of cointegration for France and not for any of the other countries. This implies that for France we will reject the null hypothesis of linear cointegration and accept the alternate hypothesis of threshold cointegration. Since the univariate tests are more restrictive than the bivariate tests, they have limited power. This is limited evidence in favor of the F-H hypothesis, in line with Coakley, Fuertes, and Spagnolo (2003).

We give a detailed discussion of the results for France, since we have the best evidence in favor of threshold cointegration for this data. The VAR estimated above for French data can be written as

$$\begin{pmatrix} \Delta(S/Y)_t \\ \Delta(I/Y)_t \end{pmatrix} = \mu + \alpha w_{t-1} + \Gamma \begin{pmatrix} \Delta(S/Y)_{t-1} \\ \Delta(I/Y)_{t-1} \end{pmatrix} + u_t$$

where $w_t = (S/Y)_t - 1.15507(I/Y)_t$,

where S/Y is the ratio of Saving to GDP and I/Y is the ratio of investment to GDP. The estimated value of β is 1.15507, implying that there is a nonlinear (existence of a threshold) and inverse relationship between Saving/GDP and Investment/GDP ratios. As explained above, the existence of threshold cointegration and a coefficient close to one implies that domestic savings and investment are closely correlated and domestic investment is primarily financed by domestic savings. This is true for France. The F-H hypothesis also states that this is an indication of a lack of international capital mobility, since domestic savings is being primarily used for financing domestic investment and not for any international purpose. This is surprising given the deregulation that has occurred worldwide over the time horizon of our study, particularly the changes implemented by France in order to become a member of the European Monetary Union and later of the common currency (which would imply a high degree of capital mobility). One possible explanation is that the government plays a large role in the economy and therefore primarily invests in the domestic economy. There is some evidence of this in the French economy. Lack of foreign savings may be explained by laws or other rules that discourage foreign investment. Another possibility is if the volume of capital inflows is comparable to the volume of capital outflows, we could still get a high correlation between savings and investment, while still having significant capital mobility as described in Georgopolous and

Hejazi (2009). Co-movement between S/Y and I/Y does not necessarily imply that domestic investment is financed primarily by domestic savings, particularly with the development of open capital markets in recent years.

The lack of threshold cointegration, and weak evidence in favor of even linear cointegration for countries like the United States could be an indication that high domestic consumption leads to low domestic savings, and therefore domestic investment has to be financed by international capital inflows. Moreover, even the low level of domestic savings are not necessarily invested in the home country as in a global economy with high degree of capital mobility investors will choose to invest wherever they can obtain the highest returns.

CONCLUSION

We have looked at the relationship between the saving-GDP and investment-GDP rations for five countries, U.S.A, U.K., France Germany, and Japan. We do find some evidence in favor of the existence of thresholds for France, but not for the other four countries. According to F-H this would imply low international capital mobility. This may be because both domestic and foreign savings are necessary to finance domestic investment, leading to a high correlation between savings and investment, but still being consistent with capital mobility. This is supported by Georgopolous and Hejazi (2009) who hypothesize that the F-H puzzle might be due to the presence of two-way capital flows. The existence of both inflows and outflows of capital may lead to highly correlated savings and investment (F-H hypothesis) in the presence of capital mobility. For the other four countries, domestic investment could either be financed significantly by foreign savings for deficit countries (as has been true in the United States) or for surplus countries domestic savings could be significantly used for foreign investment (as has been the case in Japan). For Germany, being a member of the Euro zone has led to significant capital mobility and domestic savings (and foreign savings) in the Euro zone will seek out the highest return (made easier by the integration of the economies) and domestic savings will not necessarily be correlated with domestic investment.

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