Feldstein-Horioka Puzzle and International Capital Mobility in High Income Countries: A Pool Mean Group Approach

Ibrahim Bakari Hassan, Mohamed Azali, Chin Lee

Universiti Putra Malaysia
43400 Serdang, Selangor, Malaysia
E-mail. ibrahimbakari@yahoo.com, azali@putra.upm.edu.my, leechin@econ.upm.edu.my

crossref http://dx.doi.org/10.5755/j01.ee.25.5.3539

This paper reexamines the status of international capital mobility under the Feldstein-Horioka (1980) hypothesis by comparing the results from the OECD and non-OECD high income categories. Data on savings and investment ratios of 21 OECD and 17 non-OECD countries were analyzed using the dynamic heterogeneous panel estimators of Pooled Mean Group (PMG), Mean Group (MG) and Dynamic Fixed Effects (DFE). Based on the series of Hausman post-estimation test, result from the PMG is upheld. The saving-retention coefficient, showing the level of international capital mobility, reads 0,89; 0,93 and 0,16 for the high-income group, OECD category and non-OECD category respectively. This suggests lower capital mobility in high-income as a whole and OECD countries, and higher capital mobility in the non-OECD countries. The contradictory findings confirmed that the Feldstein-Horioka saving-retention coefficient is unlikely, a viable option of measuring cross-border capital mobility. Further researches therefore need to re-observe the qualification of saving-retention coefficient in explaining international capital mobility.

Keywords: *International Capital Mobility, Feldstein-Horioka Puzzle, Financial Integration, Panel data, Pooled Mean Group, High-income Countries.*

Introduction

The degree of international capital mobility across countries has long been subject of concern, especially to policy makers. The fact that higher capital mobility is synonymous with higher financial integration attracted much interest in the field of international economics. Financial integration ensures efficient allocation of capital resources, and serves as a vendor for portfolio diversification and consumption smoothening. However, it was also understood that the integration could lead to transmissions of cross-border financial shocks among the integrated financial systems. Increasing intensity of financial interdependencies across countries harbors the risk of financial contagion (Beine *et al.,* 2010). Measuring the degree of capital mobility across countries, therefore, becomes imperative for its strategic role in policy implementation. Such resolve triggered lots of empirical investigations into the field. One of the important measurement approaches of international capital mobility is embedded in (Feldstein-Horioka, 1980) referred to as Feldstein-Horioka puzzle (hereafter referred to as F-H). The puzzle is one of the six puzzles[1] identified in the field of international macroeconomics (Obstfeld & Rogoff, 2001) and in fact, the mother of all (Sinha & Sinha, 2004). "*They are termed puzzles because they are awkward empirical facts that refuse to comply with the established theoretical framework*" (Coakley *et al.,* 1998). The presence of the puzzle makes economic theories or empirical findings more difficult to explain.

The F-H puzzle evolved from the nature of correlation between saving and investment in countries believed to have apparently reduced constraints to capital mobility. With reduced constraint to capital mobility across countries, it is expected that savings could freely be available for investment needs of all countries. Domestic investment would not be a function of domestic savings but a function of a pool of international savings. Contrary to this expectation, the work of (Feldstein & Horioka, 1980) found that in most countries (OECD in particular), domestic savings are significantly related to domestic investments. The relationship appeared to be the most challenging and controversial topic in international finance literature (Alexakis & Apergis, 1994). The result constitutes a challenge to the perception that the world capital markets are well integrated (Hoffmann, 2004). The puzzling findings generate lots of empirical explanations largely with criticism on the theoretical and econometric specifications of the earlier works. Notwithstanding the criticisms, no adequate explanation could be reached on why domestic savings is related to domestic investments. Although there is still believed that the basic intuition behind F-H approach of drawing inference from saving and investment data about the international capital mobility is still appealing (Hoffmann, 2004), the fact that the puzzle still remains, becomes an important issue. This research work partakes in the investigation by re-examining the way saving is related to investment in the countries with similar characteristics (high-income) but different sub-grouping (OECD and non-OECD). The rationale is to observe if the puzzle still exists and if it is uniform across country groups. Otherwise the puzzling findings could be the result of inability of saving-investment relation to explain the

1 The other puzzles include; the home-bias-in-trade puzzle, the home-bias portfolio puzzle, the purchasing-power-parity puzzle, the consumption correlations puzzle, and the exchange-rate disconnect puzzle.

international capital mobility. Besides, no much work can be found on high-income economies collectively, (OECD and non OECD) and also not using the dynamic heterogeneous panel estimators of PMG.

The work is structured with introduction in the above section. Next section deals with the empirical literature review where explanations about the cause of F-H puzzle are given. The subsequent section specified the estimation model followed by data presentation, followed by the empirical results. The conclusion of the study is given in the last section.

Survey of Empirical Literatures

Large number of empirical literature were registered in response to (Feldstein & Horioka, 1980) puzzle. Most of the studies show that the puzzle still remains and gave explanations as to why. These explanations range from the issue of identification, miss-specification error, simultaneity bias, sample sensitivity, problems of non-stationary variable, sample size problem, omitted variable case, and numerous others.

(Ketenci, 2013) study on 25 OECD countries show that saving-retention coefficient is influenced by country outliers, the findings adjust to country-specific cases. (Chang & Smith, 2014) on the other hand found lower capital mobility in developed countries and relatively higher in the developing countries, confirming the F-H puzzle. (Bangake & Eggoh, 2011) conducted studies on 37 African countries, using the pooled-mean-group panel techniques; their result shows low relationship between saving and investment and thus, higher capital mobility. However, the analysis on country grouping shows higher capital mobility in common law countries than in civil law countries. (Tesar, 1991) shows that the F-H puzzle could be the result of country bias, the exclusion of Luxembourg in his analysis has drastically changed the value of the β coefficient form 0,35 to 0,84. Also, the splitting of the sample data into developed and developing countries seriously affected his result. Other critiques of F-H puzzle show that the model excludes important variables that could equally explain the relationship between saving and investment in an economy. The work of (Coakley *et al.*, 1998) raises identification problem associated with F-H framework and posits that the rejection of capital mobility may be sequel to the rejection of real interest parity condition rather than the capital immobility. They show that the model of (Feldstein, 1983) suffered from identification problem; the variable specified could equally explain current account behavior. The specification showed a classical model in which national saving, investment and balance of payment are function of real interest rate and the stochastic shocks. Impliedly, in perfect capital mobility the real interest parity also holds, thus, testing for capital mobility using F-H could also mean testing for the join hypothesis of high saving-investment correlation and real interest parity. As such, the observed positive covariance between saving and investment in F-H studies might be a result of the failure of real interest parity (Coakley *et al.*, 1998).

Similarly, studies such as (Baxter & Crucini, 1993), suggest that factors such as productivity shocks, population dynamics, changes in government expenditure, and changes in interest rates may cause the co-movement between the saving and investment. The omission of these variables in the analysis, biases the result obtained by F-H studies through endogeneity problem. Similarly studies such as (Hamada & Iwata, 1989) attributes the positive correlation in F-H studies to the result of determinants of economic growth which always strive to remain in equilibrium. (Cardia, 1992) on the other hand, linked the high value of β coefficient in F-H to be consistent with financial integration.

More also the study of (Niehans, 1992) observed that the higher β coefficient was the result of differences in transaction cost between internal and external investment. On another angle, Devereux (1996) observed that tax policies in an open economy might be responsible for the relationship between saving, investment and capital account. In the same vein (Gunji, 2003) shows that the influence of domestic law substantially explains the higher value of saving retention coefficient. Studies such as (Edwards, 2004) attribute the F-H puzzle to variations in exchange rate regimes. The flexible exchange rate regime encourages less constraint to capital mobility and in turn leads to faster correction of current account imbalances. Thus, higher saving and investment could be a hallmark of development of financial sectors, where external imbalances are always quickly absorbed.

Another set of criticism of F-H result, dwelled on methodology employed. Studies such as (Bayoumi, 1990; Kasuga, 2004) claimed that the use of Ordinary Least Square techniques in the F-H study could lead to endogeneity problem. Saving and investment are influenced by interest rate, therefore, estimating the two together, results to endogeneity bias. It is also identified that the use of level data in the estimations of savings-retention coefficient results to specification bias. Measuring savings and investment in level ignore important information such as inter-temporal dynamics. Variables in level only captured the long-run relations ignoring the possible short-run relations between them. (Baxter & Crucini, 1993).

Another line of argument maintained that the variables; savings and investment, as used in F-H study are non-stationary. As such, estimating them in levels invalidate the result, especially when they are not cointegrated. In this regard (Bayoumi, 1990) used first-difference data to solve the problem. However, the work of (Sinha, 2002) shows that even the cointegration as suggested cannot be absolutely effective as it lacked power. In the same line, (De Vita & Abbott, 2002) maintained that the use of cointegration between saving and investment may not necessarily explain imperfect capital mobility; it could be the result of inter-temporal budget constraint. Works using cointegration often assumes long-run relationships between the variables without observing the stationarity properties of the data. In this response, studies turned to Autoregressive Distributed lag and Error Correction models where both the short-run and the long-run analysis of saving and investment are considered, typically the work of (Jansen & Schultz, 1996). The work of (Ho, 2000) also investigated the sensitivity of saving and investment to regime shift by employing Markoc-switching model to data from Taiwan. His result confirmed that the estimated β coefficient responds to differences in regimes.

In another development, studies such as (Eng & Habibullah, 2006) proffer solutions for omission bias and dimensionality issue by using panel methodologies to carter for all relevant information inherent in both the cross section and time series properties of the data.

Theoretical Framework

(Feldstein & Horioka, 1980) proposes a measure of degree of international capital mobility across countries by observing the correlation between domestic saving and domestic investments. The model is predicated on the fact that with financial integration, domestic investment would not be strictly correlated to domestic savings but with global savings. The work uses the model relating domestic savings with domestic investment to determine the magnitude of β coefficient referred to as saving-retention coefficient. In the presence of capital mobility, the value of β is expected to be low (close to zero), indicating low correlation between domestic saving and domestic investment. On the contrary, in the absence of cross-border capital mobility the value of β is expected to be high (close to unity). The model as specified in the F-H work is in the form:

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

Where $\left(\frac{I}{Y}\right)$ is the investment ratio, $\left(\frac{S}{Y}\right)$ is the saving ratio and the subscript i denote a country. α is the intercept and β is the rate of changes of investment as saving rate changes by one unit; referred to as the 'saving-retention coefficient".

Having specified the above model, the F-H study uses data on the cross-section averages for the sample of 16 OECD countries. From the specification it could be seen that for saving rate to be uncorrelated to investment rate, the β coefficient most be equal to or close to zero. The empirical findings of F-H however, show that the β coefficient is close to one i.e., within the interval of 0,85-0,95 indicating low capital mobility and low financial integration. Looking at the extent of capital movements across OECD countries, this finding appeared contrary to expectation and since then was anointed a puzzle.

Substantial literatures have contributed to the explanation of this puzzle, but largely concentrated on the methodological underpinnings of the earlier works. Although few works have questioned the viability of saving-investment relations in gauging the rate of international capital mobility, more need to be done, especially on the uniformity of the puzzling findings over larger country spectrums.

Methodology and Data

This study uses panel data for 38 high-income countries[2] (including 21 OECD and 17 non-OECD countries) for the period of 1990 to 2011 obtained from the World Bank databank. The variables for the analysis include gross fixed capital formation as a percentage of GDP (proxy to investment ratio), gross domestic saving as a percentage of GDP. Gross fixed capital formation is often used as a proxy for investment rate, due to data paucity on the investment rate.

For the technique of analysis, Pooled Mean Group (PMG) dynamic heterogeneous panel estimation techniques of (Pesaran *et al.*, 1999) is employed to identify the saving-retention coefficient of the saving-investment relationship. The value of the coefficients shows the extent of correlation between saving and investment in the group of countries under study. Higher-value signifies higher correlation and thus, lower international capital mobility and lower value show the reverse of the case. Although the emphasis of the analysis is on the PMG as it captures the long-run homogeneity of the data, the Mean Group (MG) estimator of (Pesaran & Smith, 1995) and Dynamic Fixed Effect (DFE) will also be provided to compare the results. Hausman test can be used to identify the efficient estimates between these estimators, particularly in their role of imposing long-run restrictions in the model.

On one end, the MG allows heterogeneity across all the parameters of the model, including; the short-run estimates, error variance and the long-run estimates, At the other extreme the dynamic fixed effect assumes homogeneity across all estimates in the model, including; error variances, short-run estimates and long-run estimates. PMG, on the other hand, assumed heterogeneity only on the short-run dynamics and error variances of the model and maintained long-run homogeneity across the groups.

The specification of PMG is more appealing to this particular study where which countries with similar economic realities are grouped together. Countries in OECD are assumed to share certain economic characteristics that may warrant identical long-run homogeneity. In addition, the technique can cater for the dynamic adjustment required to adequately capture the form of relationship between the variables over time. Moreover, larger time series dimension of our sample data requires time-series panel estimators such as the MG and PMG.

Following the presentation of the ARDL model in Pesaran *et al.*, (1999), the error correction model is in the form:

$$\Delta y_{it} = \varphi_i y_{i,t-1} + \beta_i' x_{i,t-1} + \sum_{j=1}^{p-1} \lambda_{ij}' \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \psi_{ij}' \Delta x_{i,t-j} + \nu_i + \mu_{it}, \quad (2)$$

$$i = 1,2, \dots\dots N; \quad t = 1,2, \dots..T$$

where y_{it} is a scalar of dependent variable (in our case investment ratio), x_{it} is the $k \times 1$ vector of repressors for group i, ν_i is a fixed effect and μ_{it} is the disturbance term assumed to be independently distributed across i and t with

2 *They include Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Israel, Italy, Japan, Korea Rep., Netherland, New Zealand, Norway, Portugal, Spain, Sweden, United Kingdom, United States, Bahamas, Bahrain, Barbados, Brunei Darussalam, Croatia, Cyprus, Equatorial Guinea, Estonia, Hong Kong SAR China, Kuwait, Macao SAR China, Malta, Oman, Saudi Arabia, Singapore, St. Kitts and Nevis, Trinidad and Tobago*

zero mean and variance$\delta_i^2 > 0$. $\varphi_i$is the scalar coefficient of the lagged dependent variable while β_i's is the $k \times 1$vector coefficient of regressors, λ_{ij}'s are the scalar coefficient of the lagged first-difference of dependent variables and $\psi_{ij}'s$ the $k \times 1$vector coefficient of lagged, first-difference of the explanatory variables.

The model assumed that $\varphi_i < 0$ for all i and a long run relation between the dependent variable y_{it} and the explanatory variables x_{it} is given by:

$$y_{it} = \theta_i' x_{it} + \xi_{it}, \quad i = 1,2,\ldots,N: t = 1,2,\ldots,T \quad (3)$$

Where $\theta_i' = -\beta_i'/\varphi_i$ is the $k \times 1$vector of the long run coefficients and ξ_{it} is a stationary process Therefore the order of integration of $y_{it}$is at most equal to that of x_{it}. Under these two assumptions equation (1) can be re-written as: (4)

$$\Delta y_{it} = \varphi_i \xi_{i,t-1} + \sum_{j=1}^{p-1} \lambda_{ij}' \Delta y_{i,t-j} + \sum_{j=0}^{q-1} \psi_{ij}' \Delta x_{i,t-j} + \nu_i + \mu_{it}$$

Where $\xi_{i,t-1}$is the error correction term given in equation (2), and $\varphi_i$is the coefficient of the error correction term measuring the speed of adjustment back to long-run equilibrium. The pooled mean group (PMG) estimator is derived based on the above specification where the short-run coefficients, intercept and error variances are allowed to vary across individual cross-sections or groups, while the long-run coefficients is assumed to be homogenous across the data set. This specification is in contrast to mean group (MG) which allows the heterogeneity across the entire coefficients of the model. The two models are however, computed using maximum likelihood estimation. In Pesaran *et al.*, (1999), the PMG estimation is specified in the form:

$$\hat{\varphi}_{PMG} = \frac{\sum_{i=1}^{N} \hat{\varphi}_i}{N}, \qquad \hat{\beta}_{PMG} = \frac{\sum_{i=1}^{N} \hat{\beta}_i}{N},$$
$$\hat{\lambda}_{jPMG} = \frac{\sum_{i=1}^{N} \hat{\lambda}_{ij}}{N}, \qquad j = 1,\ldots,p-1$$
$$\hat{\psi}_{jPMG} = \frac{\sum_{i=1}^{N} \hat{\psi}_{ij}}{N}, \qquad j = 0,\ldots,q-1,$$
$$and \quad \hat{\theta}_{PMG} = \hat{\theta} \qquad (5)$$

On the other hand the MG as specified in (Pesaran & Smith, 1995), is in the form:

$$\hat{\varphi}_{MG} = \frac{\sum_{i=1}^{N} \hat{\varphi}_i}{N}, \qquad \hat{\beta}_{MG} = \frac{\sum_{i=1}^{N} \hat{\beta}_i}{N},$$
$$\hat{\lambda}_{jMG} = \frac{\sum_{i=1}^{N} \hat{\lambda}_{ij}}{N}, \qquad j = 1,\ldots,p-1$$
$$\hat{\psi}_{jMG} = \frac{\sum_{i=1}^{N} \hat{\psi}_{ij}}{N}, \qquad j = 0,\ldots,q-1,$$
$$and \quad \hat{\theta}_{MG} = \frac{1}{N}\sum_{i=1}^{N} -(\hat{\beta}_i/\varphi_i) \qquad (6)$$

The difference between equation (4) and equation (5) is on the estimates of the long-run coefficient. While PMG assumed identical long-run estimates of the model in the form $\hat{\theta}_{PMG} = \hat{\theta}$, in MG such value is given by $\hat{\theta}_{MG} = \frac{1}{N}\sum_{i=1}^{N} -(\hat{\beta}_i/\varphi_i)$, meaning that the long-run estimate are obtained by taking the average of the individual country long-run values. In addition, the coefficients $\hat{\varphi}_i, \hat{\beta}_i, \hat{\lambda}_{ij}$and $\hat{\psi}_{ij}$ in MG, are estimated from equation (1) using OLS, where each of the country or individual group is estimated separately and resultant estimates are averaged across counties or groups to come up with the mean value. This process is likely to be inefficient in the cases of outliers in the data especially in small sample data. More also, the assumption of heterogonous long-run slope may also result to inefficient estimation in situation of long-run convergence across the groups. This however can be tested using Hausman-test under the null hypothesis of no significance differences between the estimated coefficients in MG and PMG and that PMG is more efficient.

In addition, before PMG estimation, requisite estimation procedures of unit root and cointegration tests are also undertaken to establish the stationarity property of the sample and the possible long-run relations. To that end, panel-unit root test of Levein, Lin & Chut, Breitung t-stat, ADF – Fisher Chi-square and PP-Fisher Chi-square techniques are used. On the other hand (Pedroni, 1999) test for cointegration is also employed to determine the long-run cointegration relation between the saving and investment.

Empirical Model

The model can be specified as follow:

$$(I/Y)_{it} = \beta_{0i} + \beta_{1i}(S/Y)_{it} + \beta_{2i}(S/Y)_{i,t-1} + \lambda_i (I/Y)_{it-1} + \nu_i + \mu_{it} \qquad (7)$$

Where $(I/Y)_{it}$ is the gross fixed capital formation as a percentage of GDP a proxy to investment rate, $(S/Y)_{it}$is the gross domestic saving as a percentage of GDP, ν_i is a fixed effect and μ_{it} is the disturbance term assumed to be independently distributed across i and t with zero mean and variance$\delta_i^2 > 0$.

After re-parameterization, the error correction representation of equation 7 would be in the form below:

$$\Delta(I/Y)_{it} = \beta_{i1}\Delta(S/Y)_{it} + \vartheta_i((I/Y)_{i,t-1} - \emptyset_{0i} - \emptyset_{1i}(S/Y)_{i,t-1}) + \varepsilon_{it} \qquad (8)$$

Where;

$$\emptyset_{0i} = \frac{\beta_{io}}{1-\lambda_i}, \quad \emptyset_{1i} = \frac{\beta_{1i} + \beta_{2i}}{1-\lambda_i} \text{and } \vartheta_i = -(1-\lambda)$$

The emphasis here is on the saving-retention coefficient $\emptyset_{1i} = \frac{\beta_{1i}+\beta_{2i}}{1-\lambda_i}$ showing the level of correlation between domestic saving and domestic investment across countries. Such estimate would however, be efficient if the long-run error correction term is significant and less than zero.

Empirical Results

The unit root test of Breitung t-statistics, Levin, lin and (Chut *et al.*, 1997) and ADF - Fisher Chi-square were tested to determine the stationarity level of the data series. The result of the test gives the basis for cointegration analysis, which requires variables to be integrated of the same order. Table 1 presents the result for unit root. Both the saving and investment ratios are non-stationary series but integrated of order one at 1 % level of significance. The null hypothesis of unit root is not rejected at level but rejected at first-difference confirming that there is a possibility of long run co-trending among the series. This applies to all the sample data of the high-income economies and the two categories OECDs and non-OECDs country group.

Panel Cointegration Test

The presence of same order unit root among saving and investment ratios confirmed that, subject to test, the cointegration relation between the series is feasible. Table 2 shows the result of (Pedroni, 1999) cointegration analysis for all the country groups. Except for few cases, both the within and between-group dimensions have shown evidence of cointegration at 1 % significance level. The two series share common long-run trend.

Table 1

Panel unit root test result

	Levin, Lin & Chu t		Breitung t-stat		Im, Pesaran & Shin W-test (1997)			ADF - Fisher Chi-square
	Statistics p-value		Statistics p-value		Statistics p-value			Statistics p-value
High income countries (31)								
$(I/Y)_{it}$	0,0892	0,5356	0,4953	0,6898	0,6062	0,7278	68,8718	0,2562
$\Delta(I/Y)_{it}$	-8,9192	0,0000	-1,0406	0,1492	-5,8621	0,0000	156,258	0,0000
$(S/Y)_{it}$	0,1930	0,5766	-0,8186	0,2065	0,3196	0,6254	65,6584	0,3513
$\Delta(S/Y)_{it}$	-12,8283	0,0000	-7,0196	0,0000	-12,4894	0,0000	255,597	0,0000
OECD countries (21)								
$(I/Y)_{it}$	-0,5249	0,2998	0,5018	0,6921	-0,1856	0,4264	56,9197	0,0620
$\Delta(I/Y)_{it}$	-7,4676	0,0000	-0,1999	0.4208	-4,2845	0,0000	94,9996	0,0000
$(S/Y)_{it}$	1,0373	0,8502	-0,8961	0.1851	1,4001	0,9193	30,9219	0,8963
$\Delta(S/Y)_{it}$	-11,5982	0,0000	-6,2811	0.0000	-8,50682	0,0000	140,779	0,0000
Non OECD countries (17)								
$(I/Y)_{it}$	-1,5735	0,0578	3,3847	0,9996	0,2925	0,6151	41,4753	0,1769
$\Delta(I/Y)_{it}$	-5,8825	0,0000	1,119	0,9465	-6,2451	0,0000	114,726	0,0000
$(S/Y)_{it}$	3,9904	1,0000	10,4550	1,0000	3,0538	0,9989	40,9623	0,1915
$\Delta(S/Y)_{it}$	-2,5000	0,0062	8,2904	1,0000	-2,6742	0,0037	85,1626	0,0000

Table 2

Pedroni Panel Cointegration test

	Within-dimension (Panel)				Between-dimension (Group)		
Country	v-Stat.	rho-Stat.	PP-Stat.	ADF-Stat.	rho-Stat.	PP-Stat.	ADF-Stat.
All High Income	9,008***	-5,579***	-6,447***	-6,881***	0,582***	-1,972***	-3,962***
OECD	3,605***	-1,899**	-2,303**	-4,791***	0,681	-1,607*	-4,132***
Non OECD	5,761***	-3,582***	-4,091***	-4,243***	0,107	-1,036	-1,373*

Note: Null hypothesis: no cointegration
*** Indicate the p-value is significant at 1 % level
** Indicate the p-value is significant at 5 % level
* Indicate the p-value is significant at 10 % level

Pooled Mean Group Estimation

Having established the presence of cointegration in the series, we determine the estimates of long-run relationship between the variables. Thus, results from the MG, DFE and PMG are relied upon to provide estimates on the magnitude of saving-retention coefficients between the country groups. The values of these coefficients show the level of international capital mobility. However, as has been pointed earlier, the specification in PMG is assumed to be more efficient for the analysis of international capital mobility. This notwithstanding, the estimates are to be subjected to Hausman-test for confirmation. The test identifies if there is any systematic difference between the MG and PMG.

Table 3 shows the saving-retention coefficient of the three estimators, together with the adjustment coefficients of the PMG and the Hausman-test results. Results of the long-run values (saving-retention coefficients) from the MG and DFE estimators appeared not significant for the high income as a whole and for the non-OECD category. However, results from the PMG estimator shows significant values for all the country groupings. This variation from the results could be a sequel to the assumptions underlying each estimator and the response to country category. Since we expect to have same long-run convergence in the saving-retention coefficients for the country groups, PMG is favored. Thus, in line with *a-priori*, we interpret the estimates of PMG but give less concern to the estimates of MG and DFE. Moreover, the results from the Hausman-test also confirmed that PMG is favored. MG did not assume identical long-run homogeneity while the DFE did not consider the possible heterogeneity in some parameters of the country groups.

In addition, the signs of the adjustment to long-run coefficients for all the estimators are negative thus, conforming to the theoretical expectations. The speed of adjustment coefficients, although, varies with estimators and groups but appeared reasonable. The value for PMG is about 18 % in high-income countries and 24 % and 23 % for OECD and Non-OECD countries respectively. On the other hand, the estimates for the short-run coefficients appeared not significant in all the groups. This indicates lack of short-run contemporaneous co-movement between savings and investment. Nevertheless, this could not have any meaningful implication in this study whose emphasis is on the long-run coefficient.

Interestingly, the long-run estimates of the saving-retention coefficient in PMG read 0,89; 0,93 and 0,16 for the high-income group, OECD category and non-OECD category, respectively. Except for non-OECD group which is significant at 5 % level the remaining two groups are significant at 1 % level. These results indicate that there is high correlation between saving and investment in the high-income counties as a whole and the OECD country group, in particular, thus, suggesting lower international capital mobility. However, the result for the 17 non-OECD countries shows lower saving investment correlation, suggesting higher international capital mobility.

The results for the high income and the OECD countries are contrary to the fact that there is evidence of capital mobility across countries. With reduction in constraint to capital movements in form of interest and exchange rate liberalization, it is evident that domestic investment is not restricted to domestic savings. The findings, therefore, contradict the expectations and appeared in support of the Feldstein-Horioka puzzle. On the contrary the result for the non-OECD countries shows low values of saving-retention coefficient suggesting the presence of capital mobility among the countries thus did not support the Feldstein-Horioka puzzle.

This contrary finding seems to question the viability of saving-retention coefficients in explaining the level of international capital mobility among country groups. It further confirmed the assertion in (Apergis & Tsoumas, 2009) that further research on the actual stand of saving-retention need to be done. The Feldstein-Horioka saving retention coefficient might have explained other factors rather than the rate of international capital mobility.

Table 3

Pooled Mean Group Estimation

	High Income			OECD			Non-OECD		
	DFE	MG	PMG	DFE	MG	PMG	DFE	MG	PMG
Long-run Coeff.	0,0820 (0,496)	-2,3536 (0,575)	0,8956 (0,000)	0,7564 (0,000)	2,0159 (0,030)	0,9228 (0,000)	-0,0526 (0,777)	-7,7514 (0,405)	0,1589 (0,028)
Adjustment Coeff.	-0,1903 (0,000)	-0,2757 (0,000)	-0,1801 (0,000)	-0,1775 (0,000)	-0,2579 (0,000)	-0,2389 (0,000)	-0,1940 (0,000)	-0,2970 (0,000)	-0,2342 (0,000)
Hausman-test	0,000 [0,9666]		0,360 [0,549]	0,000 [0,9747]		01,02 [0,3121]	0,01 [0,930]		0,48 [0,487]
Short-run Coeff.	-0,0213 (0,433)	0,0456 (0,395)	0,0257 (0,660)	0,0521 (0,132)	0,0691 (0,192)	0,1109 (0,101)	-0,0237 (0,564)	0,0164 (0,872)	-0,0237 (0,564)

Note: Values in Parenthesis are p-values for the t-statistics. Values in brackets are p-values for chi-square distribution.

Conclusion

This paper revisited the Feldstein-Horioka puzzle on international capital mobility in a sample of 38 high-income countries. Dynamic heterogeneous panel estimator of Pooled Mean Group (PMG) is employed on panel data of OECD and Non-OECD high-income countries from the period 1990 to 2011. The long-run estimates of these respective estimators represent the saving-retention coefficient, which indicates the level of international capital mobility across countries and by extension financial integration. The results obtained in the analysis revealed higher values of the saving-retention coefficient for the high-income countries as a whole and OECD group, signifying lower international capital mobility in those groups. This, however, is contrary to the *a-priori* expectations that the apparent liberalization of financial and capital instruments across high-income countries and especially the OECD group would register higher capital mobility. The result therefore shows that the F-H puzzle still exists. However, the result for non-OECD showed lower saving-retention coefficient (0,16) meaning there is higher international capital mobility and hence financial integration in these countries.

In general, the result shows that Feldstein-Horioka puzzle still holds in high-income as a group and OECD countries, but does not hold for the non-OECD high-income group. The fact that puzzling result appeared in one group of countries (OECD) and not in other group of countries (non-OECD) might be an indication of limitation of saving-retention coefficient as a measure of international capital mobility. Further research still need to be done on the way saving is related to investment.

References

Alexakis, P., & Apergis, N. (1994). The Feldstein-Horioka Puzzle and Exchange Rate Regimes: Evidence from Cointegration Tests. *Journal of Policy Modeling,* 16, 459–472. http://dx.doi.org/10.1016/0161-8938(94)90023-X

Apergis, N., & Tsoumas, C. (2009). A Survey of the Feldstein-Horioka Puzzle: What has Been Done and Where we Stand. *Research in Economics,* 63, 64–76. http://dx.doi.org/10.1016/j.rie.2009.05.001

Bangake, C., & Eggoh, J. C. (2011). Pooled Mean Group Estimation on International Capital Mobility in African Countries. *Research in Economics,* 66, 7–17. http://dx.doi.org/10.1016/j.rie.2011.06.001

Baxter, M., & Crucini, M. J. (1993). Explaining Saving-Investment Correlations. *The American Economic Review,* 83, 416–436.

Bayoumi, T. (1990). Saving-Investment Correlations: Immobile Capital, Government Policy, or Endogenous Behavior? *Staff Papers-International Monetary Fund,* 37, 360–387. http://dx.doi.org/10.2307/3867294

Beine, M., Cosma, A., & Vermeulen, R. (2010). The Dark Side of Global Integration: Increasing Tail Dependence (Digest Summary). *CFA Digest,* 40, 107–108.

Cardia, E. (1992). Crowding Out in open Economies: Results From a Simulation study. *Canadian Journal of Economics,* 25, 708–728. http://dx.doi.org/10.2307/135740

Chang, Y., & Smith, R. T. (2014). Feldstein-Horioka Puzzles. *European Economic Review,* DOI: 10.1016/j.euroecorev. 2014.09.001.

Coakley, J., Kulasi, F., & Smith, R. (1998). The Feldstein-Horioka Puzzle and Capital Mobility: a Review. *International Journal of Finance & Economics,* 3, 169. http://dx.doi.org/10.1002/(SICI)1099-1158(199804)3:2<169::AID-IJFE74>3.0.CO;2-H

De Vita, G., & Abbott, A. (2002). Are Saving and Investment Cointegrated? An ARDL Bounds Testing Approach. *Economics Letters,* 77, 293–299. http://dx.doi.org/10.1016/S0165-1765(02)00139-8

Devereux, M. P. (1996). Investment, Saving, and Taxation in an Open Economy. *Oxford Review of Economic Policy,* 12, 90–108. http://dx.doi.org/10.1093/oxrep/12.2.90

Edwards, S. (2004). Thirty Years of Current Account Imbalances, Current Account Reversals, and Sudden Stops. *IMF Staff Papers,* 51, 1–49.

Eng, Y. K., & Habibullah, M. S. (2006). Assessing International Capital Mobility in East Asian economies: A Panel Error-Correction Approach. *Journal of the Asia Pacific Economy,* 11, 411–423. http://dx.doi.org/10.1080/13547 860600923676

Feldstein, M., & Horioka, C. (1980). Domestic Savings and International Capital Flows. *Economic Journal,* 90, 314–329. http://dx.doi.org/10.2307/2231790

Feldstein, M. S. (1983). Domestic Saving and International Capital Movements in the Long Run and the Short Run. *European Economic Review,* 21, 129–151. http://dx.doi.org/10.1016/S0014-2921(83)80012-9

Gunji, H. (2003). The Feldsteina' Horioka Puzzle and Law. *Economics Bulletin,* 11, 1–12.

Hamada, K., & Iwata, K. (1989). On the International Capital Ownership Pattern at the Turn of the Twenty-First Century. *European Economic Review,* 33, 1055–1079. http://dx.doi.org/10.1016/0014-2921(89)90016-0

Ho, T. W. (2000). Regime-Switching Investment-Saving Correlation and International Capital Mobility. *Applied Economics Letters,* 7, 619–622. http://dx.doi.org/10.1080/13504850050059122

Hoffmann, M. (2004). International Capital Mobility in the Long Run and the Short Run: Can We Still Learn from Saving-investment data? *Journal of International Money and Finance,* 23, 113–131. http://dx.doi.org/10.1016 /j.jimonfin.2003.08.006

Jansen, W. J., & Schulze, G. G. (1996). Theory-based Measurement of the Saving-Investment Correlation With an Application to Noway. *Economic Inquiry,* 34, 116–132. http://dx.doi.org/10.1111/j.1465-7295.1996.tb01367.x

Kasuga, H. (2004). Saving-Investment Correlations in Developing Countries. *Economics Letters,* 83, 371–376. http://dx.doi.org/10.1016/j.econlet.2003.11.017

Ketenci, N. (2013). The Feldstein–Horioka Puzzle in Groupings of OECD Members: A panel approach. *Research in Economics,* 67, 76–87. http://dx.doi.org/10.1016/j.rie.2012.09.002

Niehans, J. (1992). The International Allocation of Savings with Quadratic Transaction (or Risk) Costs. *Journal of International Money and Finance*, 11, 222–234. http://dx.doi.org/10.1016/0261-5606(92)90043-W

Obstfeld, M., & Rogoff, K. (2001). The Six Major Puzzles in International Macroeconomics: is there a Common Cause? MIT press.

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled Mean Group Estimation of Dynamic Heterogeneous Panels. *Journal of the American Statistical Association,* 94, 621–634. http://dx.doi.org/10.1080/01621459.1999.10474156

Pesaran, M. H., & Smith, R. (1995). Estimating Long-Run Relationships from Dynamic Heterogeneous Panels. *Journal of Econometrics,* 68, 79–113. http://dx.doi.org/10.1016/0304-4076(94)01644-F

Sinha, T., & Sinha, D. (2004). The Mother of all Puzzles Would not go Away. *Economics Letters,* 82, 259–268. http://dx.doi.org/10.1016/j.econlet.2003.06.002

Tesar, L. L. (1991). Savings, Investment and International Capital Flows. *Journal of International Economics*, 31, 55–78. http://dx.doi.org/10.1016/0022-1996(91)90056-C

The article has been reviewed.

Received in February, 2013; accepted in December, 2014.