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The Feldstein-Horioka Puzzle: A Comparative Study of Developed and Emerging Market Economies

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Abstract
Many studies have discussed the Feldstein-Horioka (1980) puzzle which is the correlation between domestic savings and domestic investments that is found empirically. My paper analyses the cross-sectional regression of domestic investments on domestic savings using different empirical tests across 45 countries which include both developed and emerging market economies over a period of 40 years from 1970-2009. This paper shows that by considering unobserved heterogeneity among countries the extent of the Feldstein-Horioka puzzle is reduced and these results are backed up by econometric tests like the Pooled Estimated Generalised Least Squares test (EGLS) and the Mean Group test (MG test) as explained by Coakley, Fuertes and Smith (2001).
Keywords：Feldstein-Horioka Puzzle, Domestic Savings, Domestic Investments, Capital mobility.

1. Introduction

In their seminal paper, Feldstein-Horioka (1980) argued that in an economy with perfect capital mobility, there should be low correlation between domestic savings and domestic investments. Investors may not invest only in domestic investments but can borrow from international capital markets as well. Also savers may not invest only in domestic investments but can invest in a country with a higher marginal product of capital to increase their earnings. Therefore, domestic savings and domestic investments should be almost uncorrelated. If we accept this economic theory then statistical data should show no (or little) relation between the domestic savings and domestic investments. However, in actuality the data proves exactly the opposite. This is called the Feldstein-Horioka puzzle. It is interesting to look at this puzzle as many economists have tried to give various explanations for the puzzle but the puzzle still stands unsolved. Although the volume of work on the Feldstein-Horioka puzzle is extensive all have failed to find a common view-point. The Feldstein-Horioka puzzle has motivated a lively discussion in both theoretical and empirical literature and therefore it is good to shed some light on this topic. In this paper I try to explain what is meant by the Feldstein-Horioka puzzle, why it arises and what can be the possible ways of solving the puzzle.

This paper is divided into the following sections. Section 2 explains the theoretical background of the Feldstein-Horioka puzzle and provides the historical evidence of the puzzle. This section also highlights the theoretical and the empirical explanations of the puzzle. The data set taken for the various tests are given in section 3. In section 4, the methodology and the empirical results of the tests for the Feldstein-Horioka puzzle are interpreted and extended. And finally section 5 concludes the paper.

2. Literature Review And Theoretical Framework

2.1 Feldstein-Horioka Puzzle

The phenomenon of the Feldstein-Horioka puzzle developed from the seminal work of Martin Feldstein and Charles Horioka in 1980. Feldstein and Horioka (1980) measured the long-run cross country relationship between savings and investment rates and found a positive relation between long-run savings and investment rates across countries. Feldstein and Horioka (1980) estimated cross-section regressions of the form:

$$(I/Y)_i = \gamma_0 + \gamma_1 (S/Y)_i + \varepsilon_i, \quad \text{(i)}$$

where Y represents gross domestic product (GDP), S is gross domestic savings, I is gross domestic investment and $(S/Y)_i$ and $(I/Y)_i$ are period averages of savings rates and investment rates for each country i. All the variables are in nominal terms and in order to deal with the cyclical endogeneity of savings and investment rates, Feldstein and Horioka (1980) took long period averages of these rates. The constant term γ_0 measures the impact of the common shocks that affect all the countries' average savings and investment rates. The regression coefficient γ_1 measures whether the countries which save more also invest more on an average. [Bai and Zhang, 2010]

Feldstein and Horioka (1980) argued γ_1 should be zero in a world without any financial frictions. They based their study on a sample of 16 Organisation for Economic Cooperation and Development (OECD) countries over a period of 15 years from 1960 to 1974 and found that the value of the regression coefficient γ_1 is 0.89 with a standard error of 0.07. [Bai and Zhang, 2010] Feldstein and Horioka named the regression coefficient γ_1 as the 'saving-retention coefficient' and interpreted this as a proof of high degree of financial frictions and imperfect

international capital mobility. It appeared that domestic savings passed almost fully into domestic investments. [Taylor, 1996]

2.2 Historical Evidence of The Feldstein And Horioka Puzzle

Some applications of the Feldstein and Horioka approach in economic history are worth mentioning. Bayoumi (1989) applied the Feldstein and Horioka approach for a sample of eight countries to the classic gold-standard period before 1914. His findings suggested that the capital markets might have been better incorporated in the late nineteenth century as compared to the present. Also he found that the fit was poorer and had a lower correlation between domestic savings and domestic investments than for the contemporary data. Zevin (1992) also found similar facts in his study. Zevin (1992) used the data for eight countries in a study in which he merged price and quantity criteria for evaluating financial openness in the nineteenth and twentieth centuries. Zevin found his 'saving-retention coefficient' was not more than 0.51 for the decades from 1980s to 1920s, and also certainly was not higher than the values of the coefficient for 1960s and 1970s. [Taylor, 1996]

Of course the samples included only eight countries with imperfect information in many cases, reflecting insufficient historical statistics on national accounts and thus were criticized. Bayoumi's data excluded the United States and was thus criticized and later revalued by Eichengreen (1990). Eichengreen concluded that the conclusions drawn by Bayoumi were not so strong, as the long run correlations were significantly different from zero at conventional significance levels, except for the period 1902-1913. However the coefficient during the pre-1914 period was in the range of 0.5-0.7, smaller than the values in 1920s and 1930s, 1960s and 1970s. Eichengreen suggested that high capital mobility was not facilitated by the gold standard per se and argued that the gold standard was not qualitatively different from its predecessor. [Taylor, 1996]

While most of the studies concentrated on developed countries, some studies focused on developing countries as well. Dooley et al. (1987) found a lower savings coefficient for developing countries relative to OECD countries. They certified 'country size' as the main factor, where the small developing countries take the world interest rate as given and do not yield any upward bias on savings-investment correlation like the developed countries. The other factors responsible for the lower savings coefficient according to Dooley et al. (1987) and Payne and Kumazawa (2005) are the existence of foreign aid for developing countries and according to Payne and Kumazawa (2006) the greater capital flows. Payne and Kumazawa (2006) used a sample of 47 developing countries over a period of 1980-2003 and found a smaller Feldstein-Horioka coefficient as compared to OECD countries. [Georgopoulos and Hejazi, 2009]

Empirical studies like Ho (2002), Fouquau et al. (2008), Adedeji and Thornton (2008) followed the work of Feldstein and Horioka (1980) by using panel data that concentrated on large samples of OECD countries. Banerjee and Zanghieri (2003), Telatar et al. (2007), Kollias et al. (2008) used European Union countries while smaller samples of OECD countries were used by Georgopoulos and Hejazi (2009), Rao et al. (2010), Narayan and Narayan (2010). Studies like Sinha and Sinha (2004), Adedeji and Thornton (2008), Herwartz and Xu (2010) concentrated on groups of developed and developing countries. Studies like Ozmen and Parmaksiz (2003), Telatar et al. (2007), Mastroyiannis (2007), Kejriwal (2008) analysed the Feldstein-Horioka puzzle with the option of structural breaks in individual countries or in cross-sectional samples, while Telatar et al. (2007), Rao et al. (2010) considered structural changes in the panel data of developed countries. [Natalya Ketenci, 2010]

2.3 Theoretical Explanations of The Feldstein-Horioka Puzzle

Major theoretical hypotheses have been covered in this section of the paper.

2.4 Endogeneity of Savings and Investment and Common Factors

The problem of omission of important variables can be the reason for the Feldstein and Horioka result to be biased. Obstfeld (1985) showed that in a simple life cycle model, population growth rate played an important role as a common factor influencing both saving and investment rates. He also pointed out that the savings and investments relation is due to the immobility of labour rather than capital, and the other important factor was technological shocks. Though Obstfeld proved this hypothesis in his paper using the simulation technique, this hypothesis was not supported by many empirical studies. Feldstein and Horioka (1980, pp. 322) tried to extend (i) by including population growth but they reported the coefficient of population to be insignificant and very small. Taylor (1994) used the common factor hypothesis by carrying out regressions of savings and investment on economic growth, age-structure, product of the two and price level separately. The tests showed perfect mobility of capital as the coefficient was far from unit and was not significantly different from zero. However economists consider this as a weak hypothesis lacking empirical evidence. [Amornthum, 2003]

2.5 *International* Monetary Regimes

In the entire history of international monetary economics, there have been different monetary regimes during different time periods. For example, during the gold standard regime that emerged during the end of 19th century and in the beginning of 20th century, capital was highly mobile because of low exchange rate risk. However, the high mobility of capital was spoiled during the inter-war period from 1921 to 1944. After World War II, major countries adopted Bretton-Woods regime which introduced capital controls and led the world towards monetary instability. Finally after the temporary collapse of the Bretton-Woods agreement in 1973, countries followed

liberalization of capital movements. The values of the Feldstein-Horioka coefficient are different for different time periods. The Feldstein-Horioka result derived from the data during the Bretton-Woods regime, and reflects the true status of capital mobility at the time. Corbin (2001) and Ozmen and Parmaksiz (2003) found different Feldstein-Horioka coefficients for the Bretton-Woods regime and the post oil crises. [Amornthum, 2003]
However this argument is not justified as many studies which used the data of the post crisis period during which capital was considered to be highly mobile, could not reject the null hypothesis of imperfect mobility. Moreover the hypothesis explained the reason behind the difference in the savings and investment relationship in different time periods but failed to explain the cause of the relationship. Thus this argument is not completely futile. [Amornthum, 2003]

3. Data Set

The cross-sectional relationship between savings and investments is examined for a group of developed economies like Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Malta, Netherlands, New Zealand, Norway, Portugal, Sweden, Switzerland, United Kingdom, United States and for a group of emerging market economies like Argentina, Bangladesh, Barbados, Brazil, Chile, China, Colombia, Egypt, India, Indonesia, Iran, Malaysia, Mexico, Morocco, Oman, Pakistan, Peru, Philippines, South Africa, Sri Lanka, Thailand, Turkey over a period of 40 years from 1970-2009. The data used in this paper are taken from various sources as mentioned below. Data on Gross Domestic Product (constant 2000 US$), Gross Domestic Investment per capita (current US$), Gross Domestic Savings per capita (current US$), Gross Domestic Product per capita (current US$) are taken from World Bank national accounts data, and OECD National Accounts data files. Data on population growths (annual) are taken from (1) United Nations Population Division. 2009. World Population Prospects: The 2008 Revision. New York, United Nations, Department of Economic and Social Affairs (advanced Excel tables), (2) Census reports and other statistical publications from national statistical offices, (3) Eurostat: Demographic Statistics, (4) Secretariat of the Pacific Community: Statistics and Demography Programme, (5) U.S. Census Bureau: International Database, and (6) World Bank estimates based on the data from the sources above, household surveys conducted by national agencies, Macro International, the U.S. Centers for Disease Control and Prevention, and refugee statistics from the United Nations High Commissioner for Refugees. Consumer price indices (2005=100) are taken from International Monetary Fund, International Financial Statistics and data files.

4. Methodology and Empirical Results

This section provides different methods of estimation. These include the original Feldstein-Horioka test (Feldstein and Horioka, 1980), the Taylor regression (Taylor, 1994), introducing dynamics in the savings and investments relationship, the Pooled Estimated Generalised Least Squares Method (EGLS) and the Mean Group Estimation (MG) test (Coakley, Fuertes and Smith, 2001). The results of the different empirical estimation tests which are undertaken and also the findings made on these empirical results are provided.

4.1 *Feldstein-Horioka Test*

Using the Feldstein and Horioka (1980) cross-section regression equation given in equation (i), the 'saving-retention coefficient' given as γ_1 is estimated. This test is based on a sample of 45 countries over a period of 40 years including both developed and emerging market economies. The estimation results for the entire sample (45 countries), for emerging market economies (22 countries) and for developed countries (23 countries) are presented in table 1. Table 1 shows the results of the estimates of equation (i) for the data sets mentioned in the table. The estimate of γ_1 for the entire sample of 45 countries over a period of 40 years is 0.963 and is statistically significant. The value of the coefficient is very close to one which proves that the hypothesis that the true value of γ_1 is zero is clearly rejected. This result seems to contradict the hypothesis of perfect capital mobility and indicates that the majority of domestic savings is invested in the domestic country. Thus the international capital flows do not seem to get affected by the international differences in the savings rates. This result exhibits the presence of the Feldstein-Horioka puzzle.
Though the results obtained here are very similar to the original Feldstein and Horioka work (1980), the sample taken here is completely different and much larger. Similarly the estimate of γ_1 for emerging market economies is 0.959 and is statistically significant. Here again the value of the coefficient is very close to 1 showing the existence of the Feldstein-Horioka puzzle and the presence of high imperfect capital mobility. Finally the estimated value of γ_1 for developed countries is again close to 1 and is statistically significant.
Therefore all samples exhibit the presence of the Feldstein-Horioka puzzle. Moreover it appears that the extent of the puzzle is slightly larger in developed economies than in emerging market economies. However, these results are influenced by the presence of serially correlated residuals.
The estimation of the serial correlation of the residuals given in table 2 shows the presence of serial correlation of order one in the Feldstein and Horioka equation. This implies that the model is potentially misspecified.

One possible solution to the problem of serial correlation is to consider the same equation with variables in first differences (Frankel et al., 1986). The estimated equation is then given by :

$$\Delta(I/Y)_i = \gamma_0 + \gamma_1 \Delta(S/Y)_i + \mu_i \quad \text{(ii)}$$

The estimates of the above equation (ii) are given in table 3. The saving retention coefficient does slightly decrease compared to the previous results especially for the emerging market economies, but the extent of the Feldstein-Horioka puzzle is still large.

The Feldstein and Horioka test in this section established the existence of the puzzle in both developed countries and in emerging market economies. However, it shows that the extent of the puzzle is slightly more relevant in developed countries as compared to emerging market economies. Also the presence of serial correlation of order one in the Feldstein and Horioka equation is proved (Table 2).

4.2 *Taylor Regression*

Savings and investment functions might get affected by various determinants. Taylor (1994) uses a similar model of panel data set to control for price structures, demographic and growth effects. Savings and investments are taken as a function of factors like growth rate of economy, growth rate of population and inflation rate.

$(I/Y) = i(g, d, p)$;

$(S/Y) = s(g, d, p)$.

The regression equation used is given by the form:

$$(I/Y)_t = \gamma_0 + \gamma_1 (S/Y)_t + \gamma_2 (g)_t + \gamma_3 (d)_t + \gamma_4 (p)_t + \varepsilon_t \quad \text{(iii)}$$

where g is the growth rate of economy, d is the growth rate of population and p is the inflation rate.

Savings and investment correlations are found in many samples. However, we need to know to what extent savings crowd out investments when we control for the determinants which are common to both savings and investments. Many categories of investments and savings are affected by population choices such as spending on housing, expenditure on infrastructure and outlays on public health. The size of the working population through its impact on the scarcity of labour affects the derived demand for capital. Demographic structure is recognized as a function of economic growth and further economic development is considered as a function of investment. A rise in the relative price of investment goods lowers the profitability by lowering the quantity of a given investment. So investments are said to be negatively correlated to a shock in the price level of investment. [Taylor, 1994]

Taylor (1994) used a sample of 103 countries over a period of 1965 to 1989 in which he implemented the estimations using the determinants of real aggregate demand shares like share of private consumption (CC), investment (CI) and public consumption (CG) as dependent variables calculated at current international prices. Explanatory variables included growth rate of economy, age-structure and its interaction with the growth rate of economy and the log of the relative price of each aggregate demand component. Taylor (1994) interpreted the correlation coefficient γ_1 for duly price adjusted consumption and investment shares using the following regression run on domestic-valued residuals:

$(\text{CI domestic-valued residual})_i = \gamma_0 + \gamma_1 (\text{CC + CG domestic-valued residuals})_i + \varepsilon_i$.

The results showed that the value of the coefficient is much smaller than the Feldstein-Horioka coefficients and concluded that capital markets are said to have been more integrated and are reaching a point where the correlation between savings and investments are almost disappearing. The use of the determinants of aggregate demand was mainly to explore the other common variables and this can further help to elucidate the Feldstein-Horioka puzzle. [Taylor, 1994]

The results of the Taylor regression are obtained for the cross-sectional relation between savings and investments over a period of 1970 to 2009. The Taylor regression was carried out using the regression equation (iii) where investments were taken as the dependent variable with savings (S/Y), population growth (d), inflation rate (p) and growth rate of economy (g) as the independent variables. The results obtained are given in table 4.

The calculated value of the coefficient γ_1 for the entire sample is 0.953 which is again close to 1, thus establishing the presence of the Feldstein-Horioka puzzle even after controlling for different variables. This shows that the addition of factors like growth rate of economy, population growth rate and inflation level does not change our conclusion of the presence of the puzzle. Moreover the extent of the imperfect capital mobility again seems larger in developed economies compared to emerging market economies.

Overall the Taylor regression confirmed the presence of the puzzle in both developed and emerging market economies. No substantial changes compared to the results in previous section were found.

In the original Taylor (1994) model, he confirmed strong price, demographic and growth effects in the demand functions for private and public consumption and investment. The empirical results showed that the correlation between saving and investment almost disappeared for high income economies. However for low and middle income economies the saving-investment correlation was still significant. An explanation for the different results found in the Taylor regression can be the use of slightly different variables compared to the original Taylor (1994) model. Moreover the Durbin-Watson statistics seems low, again denoting the possibility of serial correlation.

4.3 *Introducing Dynamics In The Savings-Investment Relationship*

In this section, the original Feldstein and Horioka equation is extended by introducing dynamics into the regression specification. The presence of serial correlation in the Feldstein and Horioka test may be due to a misspecified dynamics in the investment-saving relationship. Moreover it may be reasonable to extend the dynamics of the Feldstein and Horioka equation as the investments today might also get affected by the savings in previous periods. Also the use of dynamics equation is justified as the series in the original equation given by (i) show that the investments is I(0) and savings is I(1). A process with a unit root is called integrated of order one or I(1) as it requires differencing in order to become stationary, while stationary series are denoted as I(0) as it does not need differencing to become stationary. The dynamics equation is represented by:

$$(I/Y)_t = \gamma_0 + \gamma_1(S/Y)_t + \gamma_2(I/Y)_{t-1} + \gamma_3(S/Y)_{t-1} + \varepsilon_t. \quad \text{(iv)}$$

As far as I know very little has been done in the literature about dynamics specification of the original model of Feldstein and Horioka. This is an empirical specification that will allow lagged values of both dependent and independent variables. It is difficult to find an economic model that can give rise to such a dynamics specification between investments and savings. Therefore the estimation of equation (iv) is merely an empirical exercise.

The results of the cross-sectional regression between savings and investments over a period of 1970 to 2009 are obtained using the regression equation (iv) and the results are given in table 5. From table 5 we conclude that by adding dynamics to the original equation, the contemporaneous coefficient of savings goes down slightly, but the steady state value of the savings coefficient for the entire sample is 0.9939, which is very close to 1. Therefore the dynamics specification of the Feldstein and Horioka equation shows the existence of the Feldstein-Horioka puzzle in the long run.

Further, the cross-sectional regression between savings and investments for emerging market economies over a period of 1970 to 2009 shows that the steady state value of the savings' coefficient is 0.988, which is again close to 1. The results for developed countries show that the steady state value of the savings' coefficient is 1.1495, again showing the presence of the Feldstein-Horioka puzzle in the long run.

Overall the dynamics regression equation test shows that the contemporaneous effect for developed economies is much more than for emerging market economies. Thus the Feldstein-Horioka puzzle is more in developed countries as compared to emerging market economies. However by using the dynamics equation we solve the problem of serial correlation. The Durbin-Watson statistics mentioned in table 5 which are now very close to 2, shows that the problem of serial correlation of order one has been solved.

4.4 *Pooled Estimated Generalised Least Squares Method (Egls)*

So far the results of the Taylor regression and the dynamics equation test have been unsuccessful in reducing the extent of the Feldstein-Horioka puzzle found in the Feldstein and Horioka test. The Taylor regression proved that the inclusion of variables like population growth, growth rate of the economy and inflation rate do not make any significant difference to the results. Heterogeneity among different countries might play an important role in explaining the extent of the Feldstein-Hoioka puzzle. In particular unobserved heteroegeneity will be included in the Feldstein and Horioka equation through a fixed effect estimation. Moreover another source of heterogeneity in the model that is growth rate of the economy (as measured by growth rate of real GDP) is also used. To take into account the presence of serial correlation of order one in the Feldstein-Horioka equation, an autoregressive process of order one for the residual term is included. The model looks like the following:

$$(I/Y)_{it} = \gamma_0 + \gamma_1 (S/Y)_{it} + \delta_i + \varepsilon_{it} \quad \text{(v)}$$

where $(I/Y)_{it}$ is the dependent variable, $(S/Y)_{it}$ is a k-vector of regressors and ε_{it} are the error terms for i = 1, 2,…..M cross-sectional units observed for dated periods t = 1, 2,…..T. γ_0 represents the overall constant in the model and the cross section effect δ_i is specified as a fixed effect. Residuals are allowed to follow a general AR(1) process to solve the problem of first order serial correlation. The AR(1) process is as follows:

$\varepsilon_t = \rho\varepsilon_{t-1} + \mu_t, |\rho| < 1,$

where $E(\mu_t/ X) = 0$, $E(\mu_t^2/ X) = \sigma^2_\mu$, $E(\mu_t \mu_s/ X) = 0$ for $t \neq s$.

The estimated results of the test for equation (v) over a period of 1970 to 2009 are shown in table 6. In the table, only the relevant coefficients are reported while the cross country specific coefficients are omitted for brevity.

The results from table 6 show that the coefficient value for the entire sample is significant and falls drastically to 0.626 which is much less than the value of 0.963 in the Feldstein-Horioka equation given in table 1. This shows that heterogeneity among countries can explain a substantial part of the Feldstein-Horioka puzzle. Also for emerging market economies the coefficient value falls to 0.550 which again proves a drastic fall in the coefficient value than the Feldstein and Horioka equation. Further for developed countries the coefficient value is 0.798 which is again a lower value.

Thus to conclude it can be said that by taking into consideration the unobserved heterogeneity and the presence of serial correlation the extent of the Feldstein-Horioka puzzle seems to become smaller. As in previous sections, the extent of the Feldstein-Horioka puzzle is more pronounced in developed countries than in emerging

market economies and thus capital appears to be more immobile in developed countries than in emerging market economies.

But these findings give cast an extensive doubt on the widely held view that capital is more mobile in developed countries than in emerging market economies. However, the findings above are backed up by econometric techniques and some similar results which were found by Frankel et al. (1986). Frankel et al. (1986) examined the statistical relationship between national saving and investment for a sample of 14 industrialised countries and 50 developing countries. He found that the coefficient for industrialised countries was higher than for developing countries and was higher for the period after 1973 than for the period before 1973. The puzzle of a higher saving-investment correlation for industrialised countries than for developing countries was explained by higher real exchange rate variability among the former. Frankel et al. (1986) highlighted that investment in physical capital is more responsive to the domestic market rate of return in industrialised countries than in developing countries.

4.5 *MG Estimation Test*

Coakley, Fuertes and Smith (2001) used Monte Carlo simulations to show that $\sqrt{N}$ consistent estimates of the slope coefficient can be obtained in a regression with I(1) errors using mean group (MG), fixed effects and pooled estimators for panels. Standard t-tests are used irrespective of I(0) or I(1) errors. To execute MG regression, the following regression is run separately for each country by OLS allowing for country-specific intercepts and slope coefficients :-

$(I/Y)_{it} = \gamma_0 + \gamma_1(S/Y)_{it} + \varepsilon_{it,}$ i= 1,……,N, t= 1,……..,T.

to obtain individual group slope estimates $\hat{\gamma}_1$. The MG estimator and its standard error are calculated as :-

$$\hat{\gamma}_1^{MG} = \bar{\gamma}_1 = \sum_{j=1}^{N} \hat{\gamma}_1/N \quad \text{(vi)}$$

$$se(\hat{\gamma}_1^{MG}) = \sigma(\hat{\gamma}_1)/\sqrt{N} \quad \text{(vii)}$$

where $\sigma(\hat{\gamma}_1) = \sqrt{\sum_{j=1}^{N}(\hat{\gamma_1} - \bar{\gamma}_1)^2/(N-1)}$

The MG estimator provides a measure of the average long-run savings and investments relationship in the Feldstein and Horioka framework. [Coakley, Fuertes and Spagnolo, 2001]

Differently from the Pooled EGLS estimation in previous section, here the heterogeneity among countries is not built directly inside the model.

The MG test deals with the variables that are I(1) and ADF tests show that investments is I(0) and savings is I(1). Also heterogeneity among countries justifies the use of the MG test. The MG test carries out regression separately for each country by using OLS estimation and getting country-specific intercepts and slope coefficients. The MG estimator and the standard error are calculated using the formulae mentioned in equation (vi) and (vii). Table 7 shows the results of the MG estimation test.

The calculated value of the coefficient γ_1 in table 7 for the entire sample is 0.59978 which is much less than the value of the coefficient 0.963 in the Feldstein-Horioka regression given in table 1. This shows that the value of the coefficient goes down substantially by using the MG test and the estimated coefficients are significant. For emerging market economies the coefficient value falls to 0.67 while the coefficient value of developed countries falls to 0.532, which are again significant. Differently from previous results the extent of imperfect capital mobility seems more relevant in emerging market economies than in developed economies. Moreover, non-stationarity of the residuals associated with heterogeneity, by allowing country-specific intercepts and slopes appear to be important in explaining an important part of the Feldstein-Horioka puzzle.

The result of this section is also backed by the findings of Coakley, Fuertes and Spagnolo (2001). Coakley, Fuertes and Spagnolo (2001) took a sample of 12 OECD countries over the period 1980-2000 and found the MG estimate to be 0.3276 with a standard error of 0.1765 and concluded that capital is extremely mobile in the long run as the hypothesis of perfect capital mobility cannot be rejected at the 5% significance level. So they showed that when heterogeneity is taken into consideration into a panel framework dealing with I(1) errors, the Feldstein-Horioka puzzle is reduced.

5. Conclusion

This paper discusses the Feldstein-Horioka puzzle by exploring the cross-sectional relationship between savings and investments for a group of 45 countries which include both developed and emerging market economies over a period of 1970 to 2009. Various empirical tests like the Feldstein-Horioka test, the Taylor regression, the introduction of dynamics in the savings-investment relationship, the Pooled Estimated Generalised Least Squares Method (EGLS) and the MG Estimation test are considered. Results showed that the Feldstein-Horioka puzzle arises in the sample used. Controlling for economic variables in the Taylor regression does not reduce the extent of the puzzle. The same conclusion is drawn by estimating a dynamics specification for the investment-saving relationship. However, by taking into account the unobserved heterogeneity among countries and serial correlation of the residuals, the extent of the Feldstein-Horioka puzzle is considerably reduced. In particular two

statistical procedures were performed. Using the Pooled EGLS estimation the extent of the Feldstein-Horioka puzzle was considerably reduced and capital was found more immobile in developed countries as compared to emerging market economies. Using the MG Test a similar result on the extent of the puzzle was found however the extent of capital immobility was larger in emerging market economies than in developed countries.

While unobserved heterogeneity and non-stationarity of the residuals can explain a greater part of the Feldstein-Horioka puzzle, the results are not conclusive on which cohort of countries does show greater capital immobility. Further analysis would be needed to explore more in detail such an issue. A bigger sample would also be helpful for checking the robustness of the results. Moreover, taking into account geographical proximity and inclusion of more controlling variables, may also help in shedding more light on this issue.

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Tables

Table 1: Results of the Feldstein-Horioka Test for the Investments $(I/Y)_i$

S.NO	VARIABLES	ENTIRE SAMPLE	EMERGING MARKET ECONOMIES	DEVELOPED COUNTRIES
1.	Constant (γ_0)	1076910. (166364.1)***	1911772. (338787.8)	-198357.3 (67758.77)***
2.	Savings $(S/Y)_i$	0.963080 (0.002187)***	0.959770 (0.003138)***	1.046961 (0.005105)***
3.	R^2	0.990837	0.990724	0.978684
4.	Durbin-Watson Statistic	0.282042	0.294641	0.096299
5.	Number of Observations	1796	878	918

Note: *** Significant at 99% level.

Table 2: Serial Correlation test of the Feldstein-Horioka test for the residuals (ε_t)

S.NO	VARIABLES	ENTIRE SAMPLE	EMERGING MARKET ECONOMIES	DEVELOPED COUNTRIES
1.	Constant (γ_0)	90993.13 (83882.45)	41068.36 (170058.2)	7033.382 (17813.62)
2.	Residuals (ε_{t-1})	0.892748 (0.012685)***	0.885185 (0.018695)***	0.963307 (0.010341)***
3.	R^2	0.739138	0.724390	0.906692
4.	Durbin-Watson Statistic	1.766582	1.764172	1.494701
5.	Number of Observations	1750	855	895

Table 3: Results of the first difference equation for the Investments $\Delta(I/Y)_i$

S.NO	VARIABLES	ENTIRE SAMPLE	EMERGING MARKET ECONOMIES	DEVELOPED COUNTRIES
1.	Constant (γ_0)	83895.72 (84500.25)	177145.5 (172970.3)	6272.090 (17967.40)
2.	Savings ($\Delta(S/Y)_i$)	0.837057 (0.016894)***	0.833359 (0.024280)***	1.026047 (0.027190)***
3.	R^2	0.584117	0.580027	0.614590
4.	Durbin-Watson Statistic	1.869789	1.875708	1.518379
5.	Number of Observations	1750	855	895

Table 4: Results of the Taylor regression for the Investments $(I/Y)_t$

S.NO	VARIABLES	ENTIRE SAMPLE	EMERGING MARKET ECONOMIES	DEVELOPED COUNTRIES
1.	Constant (γ_0)	-465981.4 (172325.2)***	-1655432. (1156922.)	-632529.4 (118775.8)***
2.	Savings $(S/Y)_t$	0.953305 (0.013989)***	0.952101 (0.003924)***	1.049178 (0.005283)***
3.	Growth Rate $(g)_t$	4904192. (4581823.)	10078248 (10259306)	629227.4 (2189564.)
4.	Population Growth $(d)_t$	1338717. (175790.5)***	1933626. (548132.6)***	355873.3 (102782.1)***
5.	Inflation Rate $(p)_t$	-928761.1 (262247.7)***	-936919.9 (1208811.)	2702675. (964990.4)***
6.	R^2	0.990347	0.990129	0.978754
7.	Durbin-Watson Statistic	0.266691	0.277078	0.100641
8.	Number of Observations	1550	676	874

Table 5: Results of the Dynamics equation for the Investments $(I/Y)_t$

S.NO	VARIABLES	ENTIRE SAMPLE	EMERGING MARKET ECONOMIES	DEVELOPED COUNTRIES
1.	Constant (γ_0)	122955.2 (87605.98)	261815.5 (183506.2)	-29269.95 (21187.11)
2.	Savings $(S/Y)_t$	0.832422 (0.017960)***	0.831475 (0.025748)***	1.021927 (0.027327)***
3.	Lagged Investment $(I/Y)_{t-1}$	0.899976 (0.012657)***	0.895012 (0.018554)***	0.962321 (0.010389)***
4.	Lagged Savings $(S/Y)_{t-1}$	-0.733004 (0.021117)***	-0.727731 (0.030301)***	-0.978614 (0.030486)***
5.	R^2	0.997635	0.997501	0.997996
6.	Durbin-Watson Statistic	1.771932	1.772008	1.498998
7.	Number of Observations	1750	855	895

Table 6: Results of the Pooled EGLS test for the Investments $(I/Y)_{it}$

S.NO	VARIABLES	ENTIRE SAMPLE	EMERGING MARKET ECONOMIES	DEVELOPED COUNTRIES
1.	Constant (γ_0)	9895997. (1179227.)	18498101 (1203733.)	978740.6 (207485.9)
2.	Savings $(S/Y)_{it}$	0.626106 (0.048047)***	0.550128 (0.025884)***	0.798381 (0.029760)***
3.	R^2	0.996293	0.994435	0.997154
4.	Durbin-Watson Statistic	1.762940	1.859635	1.736141
5.	Number of Observations	1697	825	872

Table 7: Results of the MG estimation test

S.NO	VARIABLES	ENTIRE SAMPLE	EMERGING MARKET ECONOMIES	DEVELOPED COUNTRIES
1.	MG Estimator $(\hat{\gamma}_1^{MG})$	0.59978	0.670186	0.532435
2.	Standard Error	0.044205	0.0582	0.067482
3.	T-Statistic	13.56804**	11.51517**	7.890043**
4.	Number of Observations	45	22	23

Note: ** Significant at 95% level.