# Capital mobility in the panel GMM framework: Evidence from EU members

Ketenci, Natalya

Yeditepe University

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Natalya Ketenci[1]

(Yeditepe University, Istanbul)

***Abstract***

This paper examines the level of capital mobility in European Union members using the generalized method of moments (GMM) estimation technique developed by Hansen (1982). This study investigates the validity of the Feldstein-Horioka puzzle within the GMM framework and the impact of the global financial crisis on the level of capital mobility in EU members. In general, the world countries with time have a tendency to a higher level of capital market openness. According to Feldstein and Horioka (1980), a higher saving-investment correlation is related to lower capital mobility. In this paper, panel data for 27 European countries were used for the period of 1995-2013 on the quarterly basis. The empirical results provide evidence of high capital mobility in EU members, obtaining a low value of a saving retention coefficient. The results of estimations indicate significant dependence of investments on its past values. It is found that the global financial crisis had a deeply negative impact on investment rates during the first three quarters of 2008, followed by a recovery in the last quarter. The empirical results indicate that the level of capital mobility increased in the first three quarters and decreased in the fourth quarter of 2008 compared to estimations without dummies. Thus increase in investments and decrease in the international capital mobility level of European countries in the last quarter of 2008 indicate a relative increase in domestic capital flows, taking into account high risk in the international market.

**JEL:** F32

**Key Words:** Capital mobility, Feldstein-Horioka puzzle, saving-investment association, generalized method of moments (GMM), EU, panel data.

[1] Natalya Ketenci, Department of Economics, Yeditepe University, Kayisdagi, 34755, Istanbul, Turkey.
Tel: 0090 2165780581. Fax: 0090 2165780797. E-mail: nketenci@yeditepe.edu.tr

## 1. Introduction

Many studies on international capital mobility in the literature have been inspired by the seminal work of Feldstein and Horioka (1980), who examined the level of capital mobility in OECD countries, estimating the following equation:

$$(IYR)_{it} = \alpha_0 + \beta(SYR)_{it} + e_{it} \tag{1}$$

Where *IYR* is the ratio of gross domestic investment to gross domestic product, *SYR* is the ratio of the gross domestic savings to the gross domestic product of considered country *i* at period *t*. Coefficient *β*, which is known as a saving retention coefficient, measures the degree of capital mobility. High international capital mobility refers to low correlation between investments and saving flows, or the value of *β*, is supposed to be close to 0. A low level of capital mobility in a country suggests a low correlation between investments and saving flows, or the value of the saving retention coefficient is supposed to be close to 1, indicating the capital immobility of the country. Feldstein and Horioka (1980) found that the value of the saving retention coefficient for developed countries is closer to 1 than to 0 value, illustrating by this international capital immobility in the considered countries. These controversial results gave start to widespread debates in the economic literature. Numerous studies have provided evidence supporting these results, but other results exist in the literature with a wide array of interpretations.

Various literature reviews were made related to the Feldstein Horioka Puzzle, for example, Tesar (1991), Frankel (1992), Coakley et al. (1998), Obstfeld and Rogoff (2000), and the latest updated literature review by Apergis and Tsoumas (2009). Obstfeld and Rogoff (2000) referred to the findings of Feldstein and Horioka (1980), which are indeed contrary to economic theory, as “the mother of all puzzles.” Frankel (1992) argued that the Feldstein

Horioka puzzle is not that surprising as it can be explained by the failure of some form of interest rate parity, for which arguments such as transaction costs and regulations can be made. The author suggested that the high value of the coefficient may be due to the procyclicality of savings and investments. Obstfeld and Rogoff (2000) suggested that the high value of the saving retention coefficient is due to the "home bias" in investor preferences. Apergis and Tsoumas (2009) concluded that the results of the majority of studies support a high correlation between savings and investments, but at a lower level. At the same time, they indicate that most studies do not validate the capital mobility hypothesis.

Most empirical studies with panel data have concentrated on large samples of OECD countries following the work of Feldstein and Horioka (1980) (see, for example, Ho 2002, 2003; Fouquau et al., 2008; Adedeji and Thornton, 2008; Ketenci, 2013), or on smaller samples of OECD countries (Georgopoulos and Hejazi, 2009; Rao et al., 2010; Narayan and Narayan, 2010). Another group of studies narrows its focus to EU countries (for example, Feldstein and Bachetta, 1991; Artis and Byoumi, 1991; Banerjee and Zanghieri, 2003; Telatar et al., 2007; Kollias et al., 2008; Ketenci, 2012).

Fouquau et al. (2008) in their study on OECD countries employed a panel smooth threshold regression approach proposed by Gonzalez et al. (2005) that can capture heterogeneity across countries and the time variability of the saving retention coefficient. The threshold variables considered in the study by Fouquau et al. (2008) are the economic growth of the considered countries, demography, degree of openness, country size, and current account balance. The authors found that the highest impacts on the international capital mobility are degree of openness, country size, and current account balance. It was found that the countries in the sample have a heterogeneous degree of international capital mobility, and that the estimated saving retention coefficients have a tendency to decline in the considered period, between 1960 and 1990.

Ho (2003), for example, employed only a country-size threshold variable for measuring its impact on the saving retention coefficient. The study was conducted for the panel of 23 OECD countries, covering the period from 1961 to 1997. The author provided substantial evidence of the threshold effects of the country size variable on the saving retention coefficient, which can be a partial explanation of FHP. Ketenci (2013) estimated the saving retention coefficient for four groups of OECD countries: OECD, EU15, NAFTA, and G7 samples. The results of the study indicated that the saving retention coefficient estimates are sensitive to panel selection. Thus, the high saving retention coefficient was found at the 0.784 level only for the G7 group, while the saving retention coefficients for other groups were detected at lower levels, rejecting the hypothesis of the Feldstein Horioka Puzzle existence.

The degree of capital mobility between EU countries has to be above the capital mobility between OECD countries due to the presence of homogenous institutions, the degree of financial openness, and regulations in the EU. This hypothesis is supported in many studies. For example, Feldstein and Bachetta (1991) and Artis and Byoumi (1991) compared EU and OECD countries in their studies on savings-investment relations and on financial integration. In both studies, the results were in favor of the higher degree of the capital mobility inside the EU than between OECD members. Kollias et al. (2008), in their studies on FHP across EU members using the ARDL bounds approach and panel data, illustrated that the savings-retention coefficient for EU15 is 0.148, and that this coefficient increases to 0.157 when Luxemburg is excluded from the panel. Therefore, the estimations of this study provided evidence of high capital mobility in the considered group of EU members, which contradicts the findings of Feldstein-Horioka (1980) for OECD countries.

Investment and saving flows are exposed to various changes in domestic as well as in world economies. Recently, more authors have started to take into account the presence of structural breaks or regime shifts using different econometric techniques. See, for example, Ozmen and Parmaksiz (2003), Telatar et al. (2007), Mastroyiannis (2007), Kejriwal (2008), Rao et al. (2010), and Ketenci(2012). Ozmen and Parmaksiz (2003), in their capital mobility analysis of the UK, and Mastroyiannis (2007), in his capital mobility analysis of Greece, did not find evidence supporting FHP in the presence of structural breaks.

Telatar et al. (2007) employed the Markov-switching model to examine the behavior of saving retention coefficients in the presence of regime change. In their study of several European countries they found evidence of increasing capital mobility in Belgium, Denmark, Finland, France, Italy and Sweden after the regime change in 1994, which was the year of the establishment of the EU. They confirmed that the saving retention coefficient declined after taking into account the regime change. Kejriwal (2008), as well as the above-mentioned authors, did not find evidence of the existence of FHP in European countries in the presence of structural breaks. However, the author argues that the reason for the overstated saving retention coefficients in the literature can be in the misspecification of regression models. Ketenci (2012) employed the Gregory and Hansen (1996) cointegration test in the presence of one structural break and the Johansen cointegration test with dummy variables, located at known points for structural dates. The results of this empirical research illustrated a low level saving retention coefficient estimated in the presence of structural breaks. The results indicate high capital mobility in most of the considered countries, providing evidence against FHP in the European Union countries sample.

This study investigates the degree of capital mobility in EU members using the panel Generalized Method of Moments (GMM) approach and its dynamic model. At the same time, it inquires into the effect of the global financial crisis of 2008 on capital mobility employing dummy variables for 2008 year quarters. In the case of perfect capital mobility, investment depends on the rate of interest; however, the decisions of investors very often depend on experience of previous decades having dynamic nature. The level of international capital mobility is exposed to various changes in domestic as well as in world economies. Particularly the global financial crisis had an impact on developed economies where fluctuations of capital flows are considered to have been one of main reasons for the crisis spread.

This topic has received significant coverage in the literature. See, for example, Baldwin (2009), Fratzscher (2011), Milesi-Ferretti and Tille (2011), and Broner et al. (2013). Broner et al. (2013), for example, argue that gross capital flows are pro-cyclical and follow economic cycles. Particularly gross capital flows significantly decrease during crises, when investors leave foreign markets. The authors found that even though such retrenchments take place during both domestic and global crises, they are much stronger under the effect of global crises.

The data sample of this study includes EU27 member countries except Greece, Ireland, Malta, and Romania because of the lack of homogenous data for these countries for the full considered period in the used source. The data for selected countries are extracted from the official statistical site of the EU, Eurostat. The quarterly data are used in this research and cover the period from 1995 to the last quarter of 2013. The rest of the paper is organized as follows. In the next section the applied methodological approach is presented. In section 3, the obtained empirical results are reported; and finally, the last section concludes.

## 2. Methodology

### *2.1 Unit root tests*

The GMM estimation framework was developed for strictly stationary data. In order to test the stationarity of panel data, four panel unit root tests were employed. These are the Im, Pesaran, and Shin (IPS) test (Im et al., 2003), Fisher-type tests that employ ADF and PP tests

(Maddala and Wu, 1999; and Choi, 2001), and Hadri tests (Hadri, 2000). The IPS test is a heterogeneous panel unit root test based on individual ADF tests and proposed by Im et al. (2003) as a solution to the homogeneity issue. It allows for heterogeneity in both the constant and slope terms of the ADF regression. Maddala and Wu (1999) and Choi (2001) proposed an alternative approach employing the Fisher test, which is based on combining the P-values from individual unit root test statistics such as ADF and PP. One of the advantages of the Fisher test is that it does not require a balanced panel. Finally, the Hadri test is a heterogenous panel unit root test that extends the KPSS (Kwiatkowski-Phillips-Schmidt-Shin) test, outlined in Kwiatkowski et al. (1992), to a panel with individual and time effects, as well as deterministic trends, which has as its null hypothesis the stationarity of the series.

### *2.2 GMM*

This study employs the GMM (Generalized Method of Moments) for a dynamic analysis of the capital mobility in the EU member countries. The GMM first was introduced by Hansen (1982) and can be recast as an instrumental variables estimation. The GMM is a flexible estimation principle where many estimators, including ordinary least squares and instrumental variables, can be seen as special cases and different econometric models can be cast. The GMM uses the orthogonality conditions to allow a weighting matrix to account for serial correlation and heteroskedasticity of unknown form. One of the important advantages of the GMM method is that the problems of heteroskedasticity and autocorrelation are avoided. Employing the GMM estimation approach, this study estimates equation 1. Additionally, this study estimates dynamic model, where lagged investment is included as an explanatory variable. The estimated dynamic regression can be written as follows:

$$(IYR)_{it} = \alpha_0 + \alpha_1 (IYR)_{it-1} + \beta (SYR)_{it} + \varepsilon_{it} \qquad (2)$$

International capital flows can be considered as of dynamic nature. Interest rate is not the only determinant of investments. At the same time decisions of investors very often depend on the experience of previous decades. Therefore, the inclusion of past value of investment as an explanatory variable gives opportunity to assess investment and saving relations under the condition of the dynamic behavior of capital flows. The level of international capital mobility is exposed to various changes in domestic as well as world economies. Particularly, the global financial crisis impacted developed economies where fluctuations of capital flows are considered as one of the main reasons for the spread of the crisis. For example, Fratzscher (2011) analyzes the effect of different drivers on capital flow patterns for a set of 50 advanced and emerging economies during the global financial crisis of 2007-2008. The findings of the paper show that common shocks such as global financial crises have substantial effects on international capital flows. Particularly the global financial crisis triggered a reallocation of capital flows from emerging market economies to advanced economies.

Therefore, in order to estimate the effect of the global financial crisis on investment-savings relations, dummy variables are included in estimated models. Thus equation (1) can be rewritten as follows:

$$(IYR)_{it} = \alpha_0 + \beta (SYR)_{it} + \alpha_2 D_j + u_{it} \qquad (3)$$

And dynamic model (2) can be rewritten as follows:

$$(IYR)_{it} = \alpha_0 + \alpha_1 (IYR)_{it-1} + \beta (SYR)_{it} + \alpha_2 D_j + v_{it} \qquad (4)$$

where *IYR* is the ratio of gross domestic investment to gross domestic product, *SYR* is the ratio of gross domestic savings to the gross domestic product of the considered country $i$ at period $t$. $D_j$ is the dummy variable which represents the global financial crisis year, 2008, where $j$ changes from 1 to 4 and denotes the quarters of 2008. The purpose of this study is to measure the saving retention coefficient $\beta$ employing the GMM approach. It is supposed that developed countries have high international capital mobility that refers to low correlation between investments and saving flows. Therefore, it is expected that the value of $\beta$ is close to 0.

## 3. Empirical Results

### *3.1 Unit root tests*

GMM estimations require stationary data, so it is necessary to investigate the integration order of the panel series. Four alternate unit root tests, consisting of the IPS, ADF, PP, and Hadri tests, were employed. The IPS, ADF, and PP tests each test for the presence of individual unit root process in series. The Hadri test's hypothesis has no unit root in the common unit root process. The results of the unit root tests are presented in Table 1. Both series, Investments and Savings, demonstrated the absence of the unit root in levels and in their first differences except the Hadri test in level estimations. The IPS, ADF, and PP tests rejected the hypothesis of the unit root presence in levels and first differences of both series. The Hadri test accepted the hypothesis of stationarity in both series in their first differences, but rejected the hypothesis of stationarity on their levels. The results of the Hadri test indicate the non-stationarity of variables; however, this might have been due to the fact that in the presence of high autocorrelation, the size distortion takes place in the Hadri test and the null hypothesis of stationarity may be over-rejected. Therefore, it is important to interpret these results with caution. Based on the results of these alternative unit root tests, it is reasonable to conclude that series are generated by a stationary process; therefore, series may be estimated by the GMM approach.

### *3.2 GMM estimations*

Table 2 presents the results of the panel estimations of equations 1 and 2 employing the GMM and the dynamic GMM methods, respectively. Additionally, the OLS and FMOLS panel estimation results of equation 1 are provided in the table to verify the robustness of conclusions. The results of the diagnostic tests suggest that all models are relatively well specified. The Sargan test does not reject the over-identification restrictions. The lagged dependent variable in equation 2 is statistically significant, indicating the reliability of the results of the specified dynamic model. The values of the saving retention coefficient appeared to be higher when the GMM and the dynamic GMM method were employed, illustrating slightly lower level of capital mobility in the estimated panel compare to the OLS and FMOLS estimations. Even though the estimated saving retention coefficient by employing the GMM and the dynamic GMM methods is slightly higher compared to the OLS and FMOLS estimations, but is still at a low level and indicates a high level of capital mobility in EU member countries. The low saving retention coefficient indicates high capital mobility in the panel sample, providing evidence for the argument against the Feldstein Horioka Puzzle. The estimation results indicate a significant dependence of investments in its past values. The results of the estimations provide evidence of the presence of restrictions for capital mobility in terms of the past values of investment flows.

Table 3 presents results for the panel sample of the GMM and the dynamic GMM estimations with the inclusion of dummy variables to examine the impact of the global financial crisis on the capital mobility of the EU member countries. D1, D2, D3, and D4 present dummy variables that correspond to the quarters of 2008, respectively. The estimated coefficients for dummy variables are presented with $\alpha_2$ coefficients. In both models, estimates of dummy coefficients were found to be highly significant. The dummy coefficients were found negative in the first and third quarters of 2008 in the GMM model estimations, indicating a significant decrease in investment rates. Estimates of dummy coefficients were found positive in the second and fourth quarters, indicating an increase in investment rates in these periods; however, the estimated rise in investments in second quarter was relatively low compared to the fourth quarter.

The estimations of the dynamic panel GMM method provided a negative sign for dummy variables in three consequent quarters. Only in the fourth quarter was the coefficient of the dummy variable found positive. The estimations results illustrate the deeply negative impact of the global financial crisis on investment rates during first three quarters followed by a strong recovery. The estimation results of the panel sample illustrate the presence of the effect of the inclusion of dummy variables on capital mobility level. In both the GMM and the dynamic GMM estimations, the saving retention coefficient was found to be at a lower level in the first three quarters compared to the estimations without dummies. In both models, the saving retention coefficient was found to be at a higher level in the fourth quarter of 2008 compared to the estimations without dummies. The estimation results indicate that the level of capital mobility in 2008 increased in the first three quarters and decreased in the fourth quarter. The results show an increase in capital repatriation in Europe at the beginning of 2008 when the global financial crisis showed its first signs.

## 4. Conclusion

This paper investigated the level of international capital flows in the panel sample of the EU27 members except Greece, Ireland, Malta, and Romania. Estimations were made for the period from 1995 to the end of 2013 on the quarterly basis. The study applied the GMM framework developed by Hansen (1982). In order to examine effect of the global financial crisis on the level of capital mobility in the selected country sample, dummy variables were employed that had been assigned for the quarters of 2008.

The estimation results in Table 2 rejected the existence of the Feldstein Horioka Puzzle in EU countries and provided enough evidence to conclude that the capital mobility level was relatively high in the selected panel sample. The estimation results revealed a significant dependence of investments on past values, indicating the presence of restrictions for capital mobility in terms of the past values of investment flows. Even in countries with high levels of capital mobility, investments are influenced by interest rate levels as well as by various obstacles. The results indicated that the investment flows of the previous quarters play a significant part in determining current capital flows and obstruct the level of perfect capital mobility.

In order to investigate the impact of the global financial crisis on the capital mobility in the EU member countries dummy variables for the quarters of 2008 were employed. The estimated coefficients for dummy variables were represented by $\alpha_2$ coefficients in Table 3. The coefficients of the dummy variables were found highly significant, indicating the presence of an effect of the global financial crisis on the level of capital mobility in the selected panel. The results of the estimates of dummy coefficients in the GMM model reveal a significant decrease in investment rates during the first and third quarters, with a slight increase during the second quarter, and a significant recovery and rise in investment rate in the last quarter of 2008. The estimations of the dynamic panel for the GMM approach provided results similar to those of the GMM model, illustrating the deeply negative impact of the global financial crisis on investment rates during the first three quarters followed by a strong recovery. The estimation results of the saving retention coefficient indicated that the level of capital mobility increased in the first three quarters of 2008, illustrating an increase in capital repatriation due to the start of the crisis. The fourth quarter of 2008 was characterized by a decrease in the capital mobility level.

This study illustrated that the level of international capital mobility in EU member countries decreased in the last quarter of 2008 under the influence of the global financial crisis; however, it did not indicate a total decrease in the capital mobility of these countries.

The dummy analysis revealed that the last quarter of 2008 was characterized by a significant increase in investment rates, providing evidence of a relative increase in domestic capital flows taking into account high levels of risk in the international market. The global financial crisis induced investors to move away from high-risk projects to safer assets, decreasing interest in new foreign direct investments abroad (Poulsen and Hufbauer, 2011). For example, Fratzscher (2011) states that the global financial crisis triggered a reallocation of capital flows from emerging market economies to advanced economies. Thus, the results of this paper demonstrate that the international capital mobility level in the EU countries was affected negatively in the last quarter of 2008. During the same period, the investment rates in European countries increased considerably, showing by this the slight move of investors from the foreign to domestic market, focusing on domestic survival. Even after detecting the negative impact of the global financial crisis on the capital mobility of the European countries, the results of this study still illustrate a high level of capital mobility, rejecting in this way the presence of the Feldstein-Horioka Puzzle hypothesis in the considered European countries.

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## 6. Appendix

Table 1. Panel Unit Root Tests

| Variables | *Investments* | | | | *Savings* | | | |
|---|---|---|---|---|---|---|---|---|
| Tests | **IPS[a]** | **ADF[a]** | **PP[a]** | **Hadri[b]** | **IPS[a]** | **ADF[a]** | **PP[a]** | **Hadri[b]** |
| *Level* | -3.19** | 71.84** | 364.07** | 6.45** | -1.96* | 58.68' | 363.33** | 15.25** |
| *Difference* | -9.63** | 200.54** | 425.23** | 0.14 | -13.42** | 281.41** | 427.92** | -1.96 |

*Notes*: In panel unit root tests, probabilities are computed assuming asymptotic normality. (a) tests the hypothesis of the presence of the individual unit root process, and (b) tests the hypothesis of no unit root in the common unit root process. * and ** denote the rejection of the null hypothesis at the 5 and 1 percent significance level, respectively.

Table 2. GMM Estimations, panel

| Dependent variable | **Investments** | **NOI** | **ST** |
|---|---|---|---|
| **GMM** | | 10 | 0.25 |
| $\alpha_0$ | - | | |
| **B** | 0.215** (0.004) | | |
| **GMM dynamic** | | 11 | 0.28 |
| $\alpha_0$ | **-** | | |
| $\alpha_1$ | -0.317** (0.005) | | |
| **B** | 0.167** (0.012) | | |
| **OLS** | | | |
| $\alpha_0$ | 19.358** (0.381) | | |
| **B** | 0.104** (0.016) | | |
| **FMOLS** | | | |
| $\alpha_0$ | - | | |
| **B** | 0.140** (0.036) | | |

*Notes*: ** and * indicate significance level at 1 and 5 percents, respectively. Standard errors for the coefficient estimates are given in parentheses. Sargan *p* values are reported. α and β coefficients are from equation 1. NOI: Number of instruments, ST: Sargan test.

Table 3. GMM Estimations, panel, with the financial crisis dummy variable.

| | **No Dummy** | **D1** | **D2** | **D3** | **D4** |
|---|---|---|---|---|---|
| **GMM** | | | | | |
| $\alpha_0$ | - | - | - | - | - |
| **B** | 0.215** (0.004) | 0.109 (0.076) | 0.201** (0.024) | 0.202** (0.049) | 0.297** (0.058) |
| $\alpha_2$ | | -54.589** (6.304) | 5.766** (1.274) | -17.782** (2.846) | 67.595** (6.115) |
| *NOI* | *10* | *5* | *7* | *7* | *7* |
| *ST* | *0.25* | *0.23* | *0.25* | *0.24* | *0.28* |
| **Dynamic GMM** | | | | | |
| $\alpha_0$ | - | - | - | - | - |
| $\alpha_1$ | -0.317** (0.005) | 0.127** (0.024) | -0.418** (0.022) | -0.330** (0.015) | -0.287** (0.032) |
| **B** | 0.167** (0.012) | 0.159** (0.072) | 0.154** (0.033) | 0.117** (0.034) | 0.222** (0.063) |
| $\alpha_2$ | | -35.165** (3.098) | -15.014** (2.469) | -2.435** (0.882 | 60.595** (7.129) |
| *NOI* | *11* | *8* | *7* | *8* | *7* |
| *ST* | *0.28* | *0.27* | *0.27* | *0.29* | *0.28* |

*Notes*: ** and * indicate significance level at 1 and 5 percents, respectively. Standard errors for the coefficient estimates are given in parentheses. Sargan *p* values are reported. NOI: Number of instruments, ST: Sargan test.