The Feldstein –Horioka Puzzle and structural breaks: Evidence from the largest countries of Asia.

Ketenci, Natalya

2014

The Feldstein –Horioka Puzzle and structural breaks: Evidence from the largest countries of Asia.

Natalya Ketenci[1]

(Yeditepe University, Istanbul)

Abstract

The purpose of this paper is to investigate the level of capital mobility in the largest economies of Asia by testing the Feldstein-Horioka puzzle. Panel estimations using quarterly data for the period from 1995 to 2011 have been made for the seven largest economies of Asia, specifically Russia, Japan, South Korea, Turkey, India, Indonesia and China. This group of countries has gained significant economic power in the world over the last decade. Specifically, the growth rates of the sample has for a long period of time exceeded the growth rates of most developed countries. The total GDP adjusted for PPP is far above of the GDP of the EU and NAFTA groups and very close to the G7 group. The paper examines changes in investment savings relationships when the presences of structural shifts – where such exist – are taken into account. Recently developed panel techniques are employed to examine the investment savings relationship and estimate saving-retention coefficients. As a result of these estimations, countries were divided into two groups consisting of stable and unstable economies. This division of countries allows for more precise estimates of capital mobility. The empirical findings reveal that the Feldstein-Horioka puzzle exists in the groups. The saving-retention coefficient is estimated at 0.804 and 0.839 for the stable and unstable samples, respectively, which indicates a relatively higher level of capital mobility among stable countries. Results indicate that countries with high capital mobility are exposed to the negative effects of international market fluctuations.

JEL: F32
Key Words: Feldstein-Horioka puzzle, saving-investment association, capital mobility, cointegration, structural breaks, Asia.

[1] Natalya Ketenci, Department of Economics, Yeditepe University, Kayisdagi, 34755, Istanbul, Turkey. Tel: 0090 5780581. Fax: 0090 5780797. E-mail: nketenci@yeditepe.edu.tr.

1. Introduction

Of late, the level of financial integration in the world has significantly increased. The spread of the effects of economic crises throughout the world is evidence of this fact. Many studies investigating capital mobility apply the work of Feldstein and Horioka (1980) on saving investment relationship. In their study, they found that investment and savings ratios are highly correlated in developed countries, which is a sign of low capital mobility. These findings are opposite to the expectation of a low correlation between investment and savings, particularly in the sample of developed OECD countries. Since then, a great deal of the attention of the literature has been afforded to the FHP, with particular focus on European or OECD countries (see, for example, Fouquau et al. [2008], Kollias et al. [2008], Herwartz and Xu [2010], Ketenci [2012, 2013]). Many studies were devoted to Asian countries, as well (see, for example, Kaya-Bahçe et al. [2008], Jiranyakul et al. [2009], Huang et al. [2006], Kim et al. [2007]). However, less attention was paid to Asian countries in panel research (see, for example, Kim et al. [2007], Guillaumin [2009], Wahid et al. [2008]), and there are no examples of panel studies of the largest Asian economies. This group of countries is worth studying due both to their dynamic development over the last years and also due to the importance of their combined market. Table 1 shows GDP information for the selected countries, as well as of major economic groups, for comparison. Note that current and real GDP of these countries exceeds GDP levels of such large markets as the European Union and NAFTA, and is very close to those of G7 countries. This, even though the regional average of real GDP per head is significantly lower compared to leading economies. However, from the last 2 columns of the table it may be determined that the share of the world's real GDP for all major regions – EU, G7 and NAFTA – has decreased since 2005, but the share of the world's real GDP for the Asian countries under consideration has increased from 28% to 33%. From Table 2, it can be seen that the growth of the largest Asian countries significantly outpaces the growth of the world's leading economic markets. For example, 2009 is characterized by a negative change in GDP of about 4% in all leading economies – EU, G7 and NAFTA. The average growth of the largest economies of Asia in 2009 was positive, though these positive growth rates are attributable to high growth in China, India and Indonesia, while other countries experienced a decline in output. Years 2010 and 2011 are characterized by a

considerable difference in the growth rates of the largest economies of Asia[2] in comparison with the EU, G7 and NAFTA. In 2010, the lowest observed growth among these economies was in Russia and Japan at about 4%, and the highest rates of growth were in China, Indonesia and Turkey, averaging 9-10%. In the same year, the EU experienced only 2% growth and NAFTA about 4%. In 2011, growth rates declined across the board, but the relative trend remained the same. This tendency favoring Asian economies is not new; with the notable exception of the Asian financial crisis, it has existed for decades.

This study differs from other studies on capital mobility in the following respects: First, it contributes to the literature on international capital mobility by providing robust estimation results using the latest econometric techniques. Second, the research investigates the relationship for the seven largest Asian countries by GDP and ascertains levels of capital mobility within the group. Third, the Hansen (1992) stability test has allowed for analysis of countries in different panels according to their relative stability, and such subdivision of the countries under consideration provides detailed results that are distinct from estimations that do not take stability into account. The remainder of the paper consists of the following sections: Section 2 outlines the empirical methodology adopted in the paper. Section 3 presents the empirical results, and section 4 draws conclusions on the data.

2. Methodology

This study investigates the degree of capital mobility of seven largest Asian countries taking into account identified structural breaks. In order to estimate the level of capital mobility in OECD countries, Feldstein and Horioka (1980) used the following equation:

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

… where I is gross domestic investment, S is gross domestic savings and Y is the gross domestic product of the country under consideration, i. Coefficient β – known as the saving-retention coefficient – measures the degree of capital mobility. If a country possesses perfect capital mobility, the value of β should approach 0. As the value of β approaches 1, it suggests the immobility of the country's capital. The results of Feldstein and Horioka's analysis showed that the value of β for 21 open OECD economies varied from 0.871 to 0.909, demonstrating a relative immobility of international capital in the countries considered. Such controversial results set off widespread debate in the economic literature, and while numerous

[2] Except Japan, which experienced a decline in GDP in 2011.

studies have corroborated the results, at the same time, contradictory results exist in the literature along, with an array of possible interpretations. The findings of Feldstein and Horioka (1980), which are indeed contrary to economic theory, have subsequently been referred to as "the mother of all puzzles" (Obstfeld and Rogoff, 2000, p.9).

1.1.Unit root tests

In this paper a variety of tests for the panel unit root are employed. The first group consists of tests that do not allow for structural changes in series, constituted by the Levin, Lin and Chu (LLC) test (Levin et al., 2002), the Breitung (Breitung, 2000) test, 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 LLC test is based on orthogonalized residuals and on the correction by the ratio of the long-run to the short-run variance of each variable. Although the test has become a widely accepted panel unit root test, it has a homogeneity restriction, allowing for heterogeneity only in the constant term of the ADF regression. The Breitung test assumes that all panels have an autoregressive parameter and a unit root process in common. The IPS test is a heterogeneous panel unit root test based on individual ADF tests and was 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. It takes as its null hypothesis the stationarity of the series.

Altogether, unit root tests do not take into account the presence of structural shifts in series. The LM unit root test, proposed by Im et al. (2005), confronts this issue. It is a panel extension of the Schmidt and Phillips (1992) test that allows for one and two structural shifts in the trend of a panel as well as of every individual time series. Im et al. (2005) illustrated that in a series where structural shifts do not exist, the size of distortions and the loss of power in the panel unit root tests remain insignificant when structural shifts are accommodated. However, size distortions and power loss in the tests are significant when unit root tests were applied to the time series without taking into account the existing structural shifts. The break date in the Im et al. (2005) test is chosen using the minimum LM statistics of Lee and

Strazicich (2003, 2004), that is to say, when the t-statistic of possible break points is minimized.

1.2.Stability test

In order to apply panel cointegration tests that allow structural shifts, it is necessary to examine a series for stability. Hansen's (1992) stability test has been employed to estimate parameter stability in cointegration relationships. The test is based on fully modified OLS residuals proposed by Phillips and Hansen (1990), and a prerequisite of the test is that the series be non-stationary. The stability test produces three test statistics: *supF*, *meanF,* and *Lc*. The *supF* statistic tests for the null hypothesis of cointegration with no structural shift in the parameter vector against the alternative hypothesis of cointegration in the presence of sudden structural shifts. The *meanF* and *Lc* statistics test for cointegration with constant parameters against an alternative hypothesis of gradual variance in parameters with no cointegration. Particularly, the *meanF* statistic is used to capture the overall stability of the model.

1.3.Cointegration tests

Cointegration tests were employed to determine whether long-run relationships exist between investment and savings. Two of them are the Kao (1999) and the Pedroni (1999) cointegration tests, which do not allow for structural shifts in series. This is followed by the Westerlund (2006) panel cointegration test, which does allow for multiple structural breaks in series. The following system of cointegrated regressors is considered for estimation in cointegration tests:

$$y_{it} = \alpha_i + \beta x_{it} + \varepsilon_{it} \qquad (2)$$

…where i=1, … , N, and t=1, … , T, α_i are constant terms, β is the slope, y_{it} and x_{it} are non-stationary regressors, and ε_{it} are stationary disturbance terms. Kao (1999) proposed two types of panel cointegration tests: the Dickey-Fuller (DF) and the Augmented Dickey-Fuller (ADF) tests. The statistics of these tests can be calculated using the following formula:

$$\hat{\varepsilon}_{it} = \rho\hat{\varepsilon}_{it-1} + \sum_{j=1}^{p}\theta_j \Delta\hat{\varepsilon}_{it-j} + u_{it} \qquad (3)$$

… where the residuals derived in the system (2) are used to calculate the test statistics (3) and tabulate the distributions. The null hypothesis of the test is $H_0 : \phi = 1$ versus the alternative $H_1 : \phi < 1$.

Pedroni (1999) developed a panel and group cointegration test where seven residual-based tests (with four panel statistics and three group statistics) were introduced in order to test the hypothesis of no cointegration in dynamic panel series with multiple regressors. The first four panel cointegration tests, which are defined as within-dimension-based statistics, use the null and alternative hypotheses: $H_0 : \phi = 1$ and $H_1 : \phi < 1$, respectively, and assume the homogeneity of coefficients under the null hypothesis. The other three groups of statistics, which are defined as between-dimension-based statistics, use $H_0 : \phi_i = 1$ versus $H_1 : \phi_i < 1$ for all *i* and assume a heterogeneous slope across countries under the alternative hypothesis.

In the long run, macroeconomic series such as investment and savings may contain a variety of structural changes at the domestic or international level. Therefore, in order to examine the regression model (1) in the case when structural breaks are detected, the methodology of Westerlund (2006) has been employed. This is a panel cointegration test that accommodates multiple structural breaks in the level as well as in the trend of cointegrated regression. It is based on the panel cointegration residual-based LM test proposed by McCoskey and Kao (1998), which does not allow for structural shifts. The advantage of Westerlund's test is that it can allow for the possibility of multiple known, *a priori* structural breaks or, alternatively, allow for breaks the locations of which are determined endogenously from the series. At the same time, the test allows for the possibility of structural breaks that may be placed at different locations in different individual series. To estimate the location of breaks, Westerlund (2006) applied the approaches of Bai and Perron (1998, 2003), which are based on the global minimization of the sum of squared residuals. He thus showed that the test is free of nuisance parameters under the null hypothesis and that the number and location of structural shifts do not affect the limiting distribution. The null hypothesis of the test is $H_0 : \phi_i = 0$ for all $i = 1,..., f, N$, versus the alternative hypothesis $H_1 : \phi_i \neq 0$ for $i = 1,..., N_1$ and $\phi_i = 0$ for $i = N_1 + 1,..., N$. One of the important advantages of the test is that the alternative hypothesis is not merely a general rejection of the null, as in the commonly used LM panel cointegration test of McCoskey and Kao (1998), but instead allows ϕ_i to differ across individual series.

2.4 Saving-retention coefficient

Finally, in order to estimate saving-retention coefficients for groups of countries the dynamic ordinary least squares (DOLS) technique was employed. The DOLS estimator was proposed by Kao and Chiang (2001) for heterogeneous panels. They illustrate that DOLS

outperform ordinary least squares and fully modified ordinary least squares estimators in estimating cointegrated panel regressions.[3]

3. Empirical results

3.1. Unit root tests

The integration order of panel series must be investigated in order to test the cointegration relationships between investment and savings panel series and to estimate saving-retention coefficients for the panel of the selected Asian countries. The results of six alternative unit root tests are presented in Table 3. All tests provided sufficient evidence to conclude that investment series are non-stationary. While most tests also provide evidence for the presence of the unit root in savings series, the Breitung and PP tests rejected this hypothesis. Based on the results of these alternative unit root tests, it may therefore be concluded that savings series are generated by a non-stationary stochastic process.

The purpose of this paper is to investigate changes in investment savings relationships in the largest economies of Asia taking structural shifts into account when they exist. To obtain stronger evidence for the presence of a unit root in both unstable and stable series, panel unit root tests that allow for one and two structural shifts in series as proposed by Im et al. (2005) were applied, and the results are summarized in Table 4. All forms of the LM unit root tests – with no structural shifts, with one, and with two shifts – provide strong evidence for the presence of the unit root in investment and savings panel series. With regard to individual countries, the LM statistics failed to reject the stationarity hypothesis only in the case of Indonesia when no shifts were allowed. When one and two structural shifts were allowed, the tests provided strong evidence of non-stationarity in all countries.

3.2. Stability test

To examine series for stability, Hansen's (1992) stability test was applied to non-stationary series, and the results are presented in Table 5. In the cases of Russia, Turkey and China, all of the statistics reject the null hypothesis of the stability of the model parameters, while in the case of Indonesia, only the *supF* statistic supports the stability hypothesis; the *MeanF* and the *Lc* statistics suggest the instability of model parameters. On the other hand, all statistics support the null hypothesis in the cases of Japan, South Korea and India. Further estimations of panels have to be made on the basis of series stability. Taking into account the results of

[3] For technical details on the DOLS estimator, see Kao and Chiang (2001).

the stability test, the considered countries may be divided into two groups. The first includes Japan, South Korea and India, where no evidence of structural changes was found. The other group would include Russia, Turkey, Indonesia and China, where at least one of the stability test statistics suggested instability.

3.3. Cointegration tests

Table 6 presents the results of Pedroni (1999) and Kao (1999) panel cointegration tests that were conducted on the stable group: Japan, South Korea and India. Most statistics reject the null hypothesis of no cointegration. The estimations of the cointegration tests provide strong evidence for the presence of cointegration relationships between investment and savings series in the panel.

Table 7 presents the results of the Westerlund (2006) panel cointegration test with multiple structural breaks, which was conducted on unstable series: Russia, Turkey, Indonesia and China. The test was applied with a parameter to detect a maximum of five structural breaks. Panel A shows the results of the test where structural shifts are allowed in constant; Panel B illustrates the results where structural shifts are allowed in both constant and trend of the regression. For these countries, the estimations of the tests detected different numbers of breaks and different break locations. Breaks in Russia, Turkey and Indonesia were identified for the period 1997-1998, years characterized by the Asian financial crisis and its contagion effects. 1998 was the year of the Russian financial crisis, which led to the devaluation of the rouble. The test showed breaks in the fourth quarter of 2000 and the first quarter of 2001 for Turkey. These dates correspond to a stock market crash after which the Turkish economy spiralled into turmoil. The global financial crisis of 2008 and its broad effects are also captured by the test in the cases of Indonesia, China and Turkey.

The statistics of the LM panel test support the null hypothesis of cointegration in the case when breaks are allowed in constant. However, when a break is allowed in constant and trend, the LM statistics reject the null hypothesis, providing no evidence for cointegration. It can be concluded that the investment and savings series in the panel of unstable countries are cointegrated only around a broken intercept. Moreover, the cointegration tests that were applied provide sufficient evidence for the presence of cointegration between investment and savings variables in stable as well as unstable countries, which in turn indicates the solvency of current accounts for these countries.

3.4. Saving-retention coefficient

The saving-retention coefficient β from Equation 1 has been estimated in order to investigate the level of capital mobility in the panels. Table 8, Panel A, presents coefficients employing DOLS estimators. Saving-retention coefficients are estimated for three samples of the Asian countries under consideration: full, stable and unstable. The full sample includes all the countries. The second consists of countries found to be stable: Japan, South Korea and India. And the third sample includes only the unstable countries: Russia, Turkey, Indonesia and China. In all samples the saving-retention coefficient was deemed significant and determined to be positive, as expected. The estimated value of the coefficient exceeds 0.8 in all samples, indicating a low level of capital mobility. Indeed, the highest value of 0.839 was in the sample of unstable countries, while in the sample of stable countries the estimated value was 0.804. In their study on saving-investment relationships in East Asian countries, Bautista and Maveyraud-Tricoire (2007) found that saving-retention coefficients changed from a pre-crisis high value to a lower value in the period following the Asian economic crisis. Similar results were found by Jun (2011), where declining saving-retention coefficients indicate increasing capital mobility for 19 Asian countries over the period 1960-2006. In the current study, post-crisis saving-retention coefficients were examined, as well (Table 8, 2000-2011 period), and a declining trend was observed, but the difference was not deemed significant.

Panel B of Table 8 presents saving-retention coefficient estimates for panel samples that exclude China.[4] The saving-retention coefficient for this sample for the 1995-2011 period was estimated to be 0.435, half of the full sample value. The coefficient estimate even decreased to 0.411 for in the post–crisis period. The estimates for the sample of stable countries including Japan, India and South Korea did not change, but the exclusion of China from the panel of unstable countries significantly decreased the value of the saving-retention coefficient to 0.178 for the 1995-2011 period and to 0.176 after the Asian crisis. This suggests high capital mobility in the considered region. China has the largest economy in the world after the United States,[5] but the exclusion of China from the panel decreases the saving-retention coefficient by half. The reason is due to low capital mobility in China, where up until the 1990s, the central bank, its municipal branches and commercial banks were subject to persistent intervention by local governments, and sometimes even had dual leadership (Li, 2010). Government intervention in China has led to inefficient capital allocation, while the dominant role of state-owned enterprises, the lack of a social safety net and artificially low

[4] Estimations were made with exclusion of every country, however the savings-retention coefficient estimates were not significantly different from the full sample. Therefore, only results of estimations with exclusion of China are considered here.
[5] 2011, IMF statistics.

interest rates have created distortion problems (Jen, 2012). When considering the six next-largest Asian countries excluding the very largest economy, China, it is important to analyze the countries in groups according to their stability. Otherwise results may be incorrectly interpreted. This study estimates the saving-retention coefficient for the full sample (excluding China) at 0.435 for the full period and at 0.411 post-crisis. These estimates demonstrate relatively high capital mobility in the considered countries for both periods, but further division of the sample into stable and unstable countries significantly changes the value of the coefficient.

The saving-retention coefficient of stable countries is estimated at 0.804 and 0.851 for the two periods, respectively, suggesting very low capital mobility in India, Japan and South Korea. Over the same periods, the saving-retention coefficient of unstable countries (again, excluding China) was estimated at 0.178 and 0.176, demonstrating very high level of capital mobility indeed in Indonesia, Russia and Turkey. Similar results were found by Ketenci (2013) in the case of OECD members, where the subdivision of panels into stable and unstable countries altered the value of the saving-retention coefficient, which was higher in stable countries and lower in unstable ones.

This study finds evidence of low capital mobility in stable countries and of high capital mobility in countries whose economies are marked by structural shifts. This means that countries with higher capital mobility are relatively more likely to experience economic instability compared to economies where level of capital mobility is low. High levels of openness and particularly of capital mobility increase the risk that a country will be exposed to instabilities channeled through international capital flows.

4. Conclusion

This paper examined the validity of the Feldstein-Horioka puzzle for the panel sample of the largest Asian countries. Recently developed econometric methods were applied to annual series in order to estimate the saving-retention coefficient and investigate the cointegration relationships of investment and savings variables, taking into account the presence of structural shifts, whenever relevant. To detect series where structural shifts took place, Hansen's (1992) stability test was employed. Four of the seven Asian countries under consideration – Russia, Turkey, Indonesia and China – were determined to be unstable. The Westerlund (2006) cointegration test was applied to the sample of unstable countries, allowing for a maximum of five breaks, and evidence of cointegration was found only when structural breaks were allowed in constant. No evidence for cointegration was found when

constant and trend were considered. The Pedroni and Kao panel cointegration tests were applied to stable countries – Japan, South Korea and India. The results provided strong evidence for cointegration between investment and savings series.

Finally, saving-retention coefficients were estimated for three samples, the full group and unstable and stable subgroups. Results using DOLS estimators indicate a low level of capital mobility in all three samples, where saving-retention coefficients were estimated at levels above 0.8. Various studies on the Feldstein Horioka puzzle in Asian countries have suggest that saving-retention coefficients for periods following the Asian crisis of 1997 differ significantly from coefficients estimated for the full or pre-crisis period. However, the estimations of the current study suggest that the differences are insignificant, indicating a low level of capital mobility.

On the other hand, estimates of saving-investment coefficients when China is excluded from the groups indicate relatively high capital mobility in the region. Indeed, the saving investment coefficients for the complete period are estimated at 0.435 and 0.178 for the full sample and the sample of unstable countries, respectively. With China excluded, estimates of saving-investment coefficients show even higher capital mobility in these countries after the Asian crisis. The study found evidence of low capital mobility in stable countries and high capital mobility in countries that experienced structural shifts, proving that countries with high capital mobility level are susceptible to the negative ramification of international market fluctuations.

5. References.

Bai, J., and P. Perron. 1998. Estimating and testing linear models with multiple structural changes. *Econometrica, 66,* 47–78.

Bai, J., and P. Perron. 2003. Computation and analysis of multiple structural change models. *Journal of Applied Econometrics, 18,* 1–22.

Bautista, C.C. & Mavyraud-Tricoire S.(2007). Saving-investment relationship, financial crisis and structural changes in East Asian Countries. *Economie internationale, 111*, 81-99.

Breitung, J. (2000). The local power of some unit root tests for panel data. *Advances in Econometrics, Volume 15: Nonstationary Panels, Panel Cointegration, and Dynamic Panels*, ed. B. H. Baltagi, 161–178. Amsterdam: JAY Press.

Choi, I. (2001). Unit Root Tests for Panel Data. *Journal of International Money and Finance*, *20*, 249-272.

Feldstein, M., & Horioka, C. (1980). Domestic saving and international capital flows. *Economic Journal, 90*, 314–329.

Fouquau, J., Hurlin, C., & Rabaud, I. (2008). The Feldstein-Horioka puzzle: A panel smooth transition regression approach. *Economic Modelling, 25*, 284-299.

Hadri, K. (2000). Testing for stationarity in heterogenous panel data. *Econometrics Journal,* 3(2), 148-161.

Hansen, E. B. (1992). Tests for parameter instability in regressions with I(1) process. *Journal of Business and Economic Statistics,10(3),* 321-335.

Herwartz, H. & Xu, F. (2010). A functional coefficient model view of the Feldstein–Horioka puzzle. *Journal of International Money and Finance, 29(1),* 37-54.

Huang, Y. & Guo, F. (2006). An Empirical examination of Capital Mobility in east Asia Emerging Markets. *Global Economic Review, 35(1),* 97-111.

Jen, S.L. (2012). The Return of the Feldstein-Horioka Puzzle. Global Connections, Itau BBA.

Jiranyakul, K. & Brahmasrene, T. (2009). An Exploratory Inquiry of the Feldstein-Horioka Puzzle in Selected Southeast Asian countries. *Journal of Transnational Management, 14(4)*, 259-276.

Jun, S. (2011). The Savings-Investment correlation in Asian countries. *Pacific Science Review, 12(3),* 321-330.

Guillaumin, C. (2009). Financial Integration in East Asia: Evidence From Panel Unit Root and Panel Cointegration Tests. *Journal of Asian Economics, 20,* 314-326.

Im, K.S., Lee, J. & Tieslau, M. (2005). Panel LM unit-root tests with level shifts. *Oxford Bulletin of Econometrics and Statistics 67(3),* 393–419.

Im, K.S., Pesaran, M.H. & Shin, Y. (2003). Testing for unit root in heterogenous panels. *Journal of Econometrics, 115(1)*, 53-74.

Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. *Journal of Econometrics, 90*, 1–44.

Kao, C. & Chiang, M.H. (2001). On the Estimation and Inference of a Cointegrated Regression in Panel Data. *Advances in Econometrics, 15*, 179–222.

Kaya-Bahçe, S. & Özmen, E. (2008). Exchange Rate Regimes, Saving glut and the Feldstein-Horioka Puzzle: The East Asian Experience. *Physica A: Statistical Mechanics and its Applications, 387(11),* 2561-2564.

Ketenci, N. (2012). The Feldstein-Horioka Puzzle and structural breaks: Evidence from EU members. *Economic Modelling, 29(2),* 262-270.

Ketenci, N. (2013). The Feldstein-Horioka Puzzle in groupings of OECD members: a panel approach. *Research in Economics, 67(1),* 76-87.

Kim, S., Kim, S.H. & Wang, Y. (2007). Saving, Investment and International Capital Mobility in East Asia. *Japan and the World Economy, (19),* 279-291.

Kollias, C., Mylonidis, N., & Paleologou, S.M. (2008). The Feldstein- Horioka puzzle across EU members: Evidence from the ARDL bounds approach and panel data. *International Review of Economics and Finance, 17*, 380-387.

Kwiatkowski, D., Phillips, P.C.B, Schmidt, P. & Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? *Journal of Econometrics, 44*, 159-178.

Lee, J. & Strazicich, M. (2003). Minimum Lagrange multiplier unit root test with two structural breaks. *Review of Economics and Statistics, 85,* 1082–1089.

Lee, J. & Strazicich, M.C. (2004). Minimum LM unit root test with one structural break. *Working Papers 04-17*, Department of Economics, Appalachian State University.

Levin, A., Lin, C.F. & Chu, C.S.J. (2002). Unit root tests in panel data: Asymptotic and finite-sample properties. *Journal of Econometric, 108(1),* 1-24.

Li, C. (2010). Savings, investment, and capital mobility within China. *China Economic Review, 21(1),* 14-23.

Maddala, G.S. & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and Statistics, 61,* 631–652.

McCoskey, S. & Kao, C. (1998). A residual-based test of the null of cointegration in panel data. *Econometric Reviews, 17(1),* 57-84.

Obstfeld, M., & Rogoff, K. (2000). Perspectives on OECD economic integration: Implications for U.S. Current Account Adjustment. UC Berkeley: Center for International and Development Economics Research. Retrieved from: http://escholarship.org/uc/item/16z3s2s2

Bautista, C.C. & Maveyraud-Tricoire, S. (2007). Saving-investment relationship, financial crisis and structural changes in East Asian countries. *Economie Internationale, CEPII research center, 111*, 81-99.

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics November* (Special Issue), 653–669.

Phillips, P.C.B., & Hansen, B.E. (1990). Statistical Inference in Instrumental Variables Regression with I(1) Processes. *Review of Economic Studies*, 57, 99-125.

Schmidt, P. & Phillips, P. C. B. (1992). Testing for a unit root in the presence of deterministic trends. *Oxford Bulletin of Economics and Statistics, 54*, 257-287.

Wahid, A.N.M., Slahuddin, M. & Noman, A.M. (2008). Saving Investment Correlation in South Asia-A Panel Approach. *European Journal of Economics, Finance and Administrative Sciences, 11*, 153-159.

Westerlund, J. (2006). Testing for Panel Cointegration with Multiple Structural Breaks. *Oxford Bulletin of Economics and Statistics*, 68(1), 101-132.

6. Appendix

Table 1.GDP of major Asian countries and major economic groups in 2011

Country	GDP[a]	GDP PPP[b]	GDP PPP per head[c]	GDP PPP share of the world total, %.	GDP PPP share of the world total, % (2005).
China	5,878,257	10,085,708	7,518	14.32	9.45
India	1,537,966	4,060,392	3,339	5.65	4.28
Indonesia	706,735	1,029,884	4,394	1.42	1.24
Japan	5,458,872	4,309,432	32,817	5.62	6.85
Russia	1,465,079	2,222,957	15,807	3.02	2.99
South Korea	1,007,084	1,459,246	30,200	1.97	1.93
Turkey	729,051	960,511	13,392	1.36	1.32
Total	*19,434.18*	*26,333.89*	*16,349.77*	*33.37*	*28.05*
EU	17,577.69	15,821.26	31,607.39	20.05	23.03
G7	33,670.02	30,355.27	40,891.57	38.47	45.03
NAFTA	17,985.68	18,151.80	34,512.52	23.01	26.50

Notes: Figures in [a] in billions of current U.S. dollars, [b] billions of current international dollars, [c] and current international dollars, respectively. The table is based on statistical data produced by the IMF.

Table 2. GDP growth rates (% compared to the previous year)

Country	2005	2006	2007	2008	2009	2010	2011
China	11.310	12.677	14.162	9.635	9.214	10.447	9.237
India	9.033	9.530	9.991	6.186	6.579	10.623	7.241
Indonesia	5.693	5.501	6.345	6.014	4.629	6.195	6.457
Japan	1.303	1.693	2.192	-1.042	-5.527	4.435	-0.748
Russia	6.388	8.153	8.535	5.248	-7.800	4.300	4.300
South Korea	3.957	5.179	5.106	2.298	0.319	6.320	3.634
Turkey	8.402	6.893	4.669	0.659	-4.826	9.006	8.460
Average[1]	*6.584*	*7.089*	*7.286*	*4.143*	*0.369*	*7.332*	*5.512*

EU[1]	2.186	3.6	3.395	0.512	-4.208	2.003	1.618
G7[1]	2.282	2.608	2.243	-0.38	-4.042	3.036	1.379
NAFTA[1]	3.090	3.543	2.452	0.513	-4.177	3.929	2.721

Notes: [1] average calculations. The table is based on statistical data produced by the IMF.

Table 3. Unit root tests

Variable	level	*Δ*	Variable	Level	*Δ*
Investment			**Savings**		
LLC[a]	-0.47	-22.41*	LLC	1.82	1.40
	I(1)	I(0)		I(1)	I(1)
Breitung[a]	-0.40	-12.35*	Breitung	-2.23*	-4.39*
	I(1)	I(0)		I(0)	I(0)
IPS[b]	-0.39	-21.39*	IPS	-0.27	-6.49*
	I(1)	I(0)		I(1)	I(0)
ADF[b]	16.46	169.87*	ADF	10.85	66.26*
	I(1)	I(0)		I(1)	I(0)
PP[b]	16.03	192.17*	PP	28.38	187.00*
	I(1)	I(0)		I(0)	I(0)
Hadri[c]	6.14*	-0.58	Hadri	6.11*	-0.69
	I(1)	I(0)		I(1)	I(0)

Notes: Estimations are made with the inclusion of constant and trend. Estimations are made with maximum 4 specified lag. With the increase of lag, the length of the power of tests increases in favor of the unit root presence in level estimations. * denotes significance at a 5% level; [a] tests the hypothesis that the common unit root process is present, [b] tests the hypothesis that the individual unit root process is present, and [c] tests the hypothesis that there is no unit root in the common unit root process.

Table 4. Panel unit root test with structural shifts

Investment	**No shifts**		**One shift**			**Two shifts**			
Country	*LM*	*Lag*	*LM*	*Break*	*Lag*	*LM*	*Break1*	*Break2*	*Lag*
Russia	-8.06***	1	-11.07***	Q4-2009	5	-11.72***	Q3-1997	Q1-1999	5
Japan	-6.10***	4	-9.48***	Q4-1998	0	-10.89***	Q3-2006	Q4-2008	0
South Korea	-8.38***	1	-10.09***	Q1-2010	5	-13.01***	Q4-2004	Q1-2010	5
Turkey	-8.03***	1	-11.38***	Q2-1998	5	-13.35***	Q4-2005	Q2-2007	5
India	-9.24***	0	-10.15***	Q2-2004	0	-13.44***	Q4-2003	Q3-2005	5
Indonesia	-1.83	3	-10.61***	Q1-1997	5	-12.16***	Q1-1997	Q3-1999	5
China	-10.52***	0	-10.11***	Q3-2005	5	-11.63***	Q3-2007	Q1-2009	5
MinLM			-10.11***	Q3-2005	5	-11.63***	Q3-2007	Q1-2009	5
LM statistic	-24.412***		-37.763***			-46.232***			
Savings	**No shifts**		**One shift**			**Two shifts**			
Country	*LM*	*Lag*	*LM*	*Break*	*Lag*	*LM*	*Break1*	*Break2*	*Lag*
Russia	-7.63***	0	-9.63***	Q4-2009	5	-11.27***	Q3-1999	Q1-2010	5
Japan	-8.11***	4	-11.49***	Q4-2009	5	-10.52***	Q1-2008	Q4-2008	5
South Korea	-8.35***	4	-9.43***	Q3-2008	5	-10.20***	Q2-2002	Q1-2010	5
Turkey	-6.16***	4	-9.92***	Q3-2006	5	-10.89***	Q3-2006	Q1-2010	5
India	-8.64***	4	-11.80***	Q2-2000	5	-14.91***	Q2-2000	Q1-2010	5
Indonesia	-6.36	0	-8.24***	Q1-2009	0	-13.05***	Q1-1997	Q3-2001	5
China	-8.13***	4	-12.32***	Q1-2003	5	-12.50***	Q3-2001	Q1-2003	5
MinLM			-12.32***	Q1-2003	5	-12.50***	Q3-2001	Q1-2003	5
LM statistic	-25.410***		-37.740***			-44.441***			

Notes: For the minimum LM test with one break, the critical values for the 1%, 5% and 10% levels of significance are –5.11, –4.50 and –4.21, respectively (Lee and Strazicich (2003)). ***, ** and * denote the 1%, 5% and 10% levels of significance.

Table 5. Stability tests in cointegrated relations

Country	*SupF*		*MeanF*		*Lc*	
	test	p-value	Test	p-value	test	p-value
Russia	0.53	0.08	9.43	0.01	58.55	0.01

Japan	0.14	0.20	1.05	0.20	1.36	0.20
South Korea	0.20	0.20	2.55	0.20	10.47	0.20
Turkey	1.07	0.01	12.26	0.01	40.66	0.01
India	0.19	0.20	2.73	0.20	9.46	0.20
Indonesia	0.16	0.20	12.34	0.01	24.26	0.01
China	0.39	0.17	4.42	0.16	12.95	0.11

Notes: p-values are obtained from the GAUSS program and are associated with the computed statistics taken from Hansen (1992). A series is said to be stable if the estimated probability is 20%. If the p value is smaller than 20%, the null hypothesis that the model parameters are stable is rejected.

Table 6. Panel cointegration tests (for stable countries)

STABLE		c	c&t
Pedroni			
Panel v-Statistic	2.26**	0.72	-0.23
Panel rho-Statistic	-5.83**	-3.66**	-0.83
Panel PP-Statistic	-3.34**	-2.75**	-0.99
Panel ADF-Statistic	-3.67**	-3.02**	-1.39
Group rho-Statistic	-4.68**	-3.27**	-0.45
Group PP-Statistic	-3.56**	-2.61**	-0.46
Group ADF-Statistic	-4.08**	-2.97**	-1.30
Kao			
ADF		-3.37**	

Notes: The critical values are based on Pedroni (2004). Hypothesis for the Pedroni and Kao cointegration tests: No cointegration. ** and * reject the hypothesis of no cointegration at the 1% and 5% levels of significance, based, respectively, on critical values of 2.326 and 1.644. Lag selection is based on the SIC with maximum of 3 lags.

Table 7. Estimated structural breaks using the approach of Westerlund (2006) (for unstable countries)

Panel A breaks in constant						
Country	Breaks	Year				
Russia	3	Q2-1997	Q2-2000	Q4-2006		
Turkey	2	Q4-2000	Q3-2003			
Indonesia	4	Q3-1998	Q2-2003	Q1-2006	Q3-2008	
China	2	Q4-2004	Q1-2009			
Lm	1.484					
Panel B breaks in constant and trend						
Country	Breaks	Year				
Russia	3	Q2-1998	Q4-2001	Q4-2006		
Turkey	5	Q2-1998	Q1-2001	Q3-2003	Q2-2006	Q1-2009
Indonesia	3	Q2-1997	Q4-1999	Q4-2008		
China	1	Q4-2005				
Lm	3.581*					

Note: The null hypothesis of the test is cointegration. * reject hypothesis of cointegration based on the bootstrap p-values at the 5% level of significance. The breaks are estimated using the Bai and Perron (2003) procedure with a maximum of five breaks.

Table 8. DOLS estimations of the saving-retention coefficient

	1995-2011		**2000-2011**	
Sample	**Constant**	**β**	**Constant**	**β**
Panel A				
Full	2.646 (0.937)**	0.808 (0.031)**	2.996(1.031)**	0.807(0.034)**
Stable	4.215 (0.775)**	0.804 (0.027)**	2.949(0.903)**	0.851(0.032)**
Unstable	0.639 (1.344)	0.839 (0.042)**	1.581(1.476)	0.824(0.046)**
Panel B				
Full sample without China	12.015 (1.063)**	*0.435 (0.038)***	12.840 (1.177)**	*0.411(0.043)***
Unstable sample without China	16.305 (1.147)**	*0.178 (0.042)***	16.594 (1.230)**	*0.176 (0.046)***

Notes: Standard errors are given in brackets. Saving-retention coefficients β are estimated for 3 sets of countries: total, unstable and stable. The *total* set includes all countries of a given group, the second set includes only the unstable countries, while the last set includes only stable countries. In order to test the hypothesis that β=0, critical values from the normal standard distribution are used. The critical values at the 1% and 5% levels of significance for rejecting the hypothesis are 2.575 and 1.96 respectively.