

## A dynamic relationship between savings and investment: The tales of China and the ASEAN-5

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**Abstract:** This paper applies recursive cointegration analysis to examine the dynamic changes in Feldstein-Horioka (1980) savings-investment (S-I) coefficients across China and the ASEAN-5 countries over time. To the extent that the S-I coefficients measure international capital mobility, the main empirical results are as follows. First, the recursive trace statistics show that savings-investment linkages vary in these six countries. Second, there is no cointegration between the two factors in four countries - China, Singapore, Malaysia, and Thailand - meaning that capital market mobility in these countries is high and domestic investment in the four is financed by the global pool of capital. Third, for Indonesia and Philippines, there is a cointegration between savings and investment before 2001 for them, implying that they achieved highly mobile and open capital markets later than the other countries.

**Keywords:** Savings, Investment, Recursive cointegration test, ASEAN, China

### INTRODUCTION

East Asia has become more integrated through strong growth in cross-border trading and economic activities over the past two decades, which also have resulted in greater cross-border financial activities. Some important works that refer to trade and finance for regional institution building have targeted this region. In the financial arena, governments have encouraged cross-border financial transactions through financial market deregulation and capital account liberalization. Thus, the emerging stock markets of China and ASEAN countries have played a more important role for international fund managers to manage portfolio diversification. Under this background, this paper examines mobile capital movement among China and the ASEAN-5 countries, and most notably whether the degree of capital mobility has increased due to the region's deepening development of economic integration.

There are many dynamic emerging economies in East Asia, with most of them regulating capital flows across countries during the period from the 1960s to 1970s. In the 1980s, these economies deregulated exchange rate controls and carefully and gradually initiated measures for capital account liberalization. In

the 1990s, they speeded up the liberalization of their capital markets so as to increase international capital mobility. These capital account deregulation policies caused substantial capital inflows into the region in the 1990s, eventually being one of sparks for the 1997 Asian financial crisis.

Some academic papers have also investigated international market linkages with East Asia markets. A frequently reported stylized fact in modern open economies is the degree of mobile capital between countries with some methods proposed to analyze this topic. One strand of the related literature is advocated by Feldstein and Horioka [1](hereafter, FH), who estimate how closely related savings and investment are across countries. The literature on the FH puzzle has quickly grown, with extensive empirical studies of the issue differing significantly in terms of the methodology applied, the dataset, and sample periods covered.

Numerous studies use cross-section regressions to examine the FH puzzle by comparing the results of different countries, such as Artis and Bayoumi [2], Dooley, Frankel, and Mathieson[3], Feldstein[4], Feldstein and Bachetta[5], Murphy[6], Obstfeld[7],

Penati and Dooley[8], Tesar [9], etc. Another line of the literature applies time-series analysis to provide a wider dispersion of savings-investment (SI) coefficients, including Alexakis and Apergis [10], Apergis & Tsoufidis[11], Bajo-Rubio[12], Caporale, Panopoulou, and Pittis [13], De Vita and Abbott [14], Obstfeld[15], Pelagidis and Mastroianni [16], Sinha & Sinha[17-18], etc. By considering the use of full information of the data and in order to improve several of the shortcomings of individual time series methods, an increasing number of recent studies has chosen the panel data methodology for analysis, such as Coakley and Kulasi [19], Coakley, Kulasi and Smith[20], Corbin [21], Ho[22], Jansen [23], Kim [24], Kollias, Mylonidis and Paleologou [25], etc.

Most empirical studies focus on examining the FH puzzle in OECD countries and developed countries, with few papers the issue in developing countries. Hence, this paper looks at the FH puzzle in China and the ASEAN-5 countries to fill the gap in the literature. The above-mentioned literature treats the relationship between savings and investment as a static concept, but this assumption may not be warranted, because structural breaks are a common problem in a macroeconomic series. Instead, linkages between savings and investment may be time-varying and episodic. In the long run, a macroeconomic series that includes savings and investment may contain a variety of structural changes, or be described as undergoing a gradual and ongoing process, which is not a static concept, within a country or at the international level. Hence, considering the importance of time variation in the savings and investment nexus, this paper employs recursive cointegration to study the dynamic evolution of the long-run relationship between the two, which is the Feldstein-Horioka model. Recursive cointegration tests[26] can analyze the degree of convergence during different sub-sample periods of the full sample by using the cointegration rank tests of Johansen[27-28]. The results shall explain the implications of the time-varying behavior of these linkages in China and the ASEAN-5.

## LITERATURE REVIEW

For the last several decades the Feldstein-Horioka puzzle has been discussed and examined by many studies. The literature includes some excellent surveys of the related works, such as Obstfeld and Rogoff[29] and Apergis and Tsoumas[30]. Many theoretical papers have targeted to resolve the puzzle, including setting up a model of non-traded goods[31], an IS-LM model considering the optimal policy[32], a model with long-run current account solvency[20, 32], a model with trade costs and barriers[29], non-linearity between the current account and real interest rate[34-35] and more financial frictions[36].

Some papers discuss the FH puzzle by applying different methodology and econometric techniques. In general, this puzzle has been mainly replicated using cross-section regressions (see, among others [2-9], Time-series analysis has provided a wider dispersion of the FH puzzle [10-19]. For example, Jansen (1997, 2000) indicates that the high correlation between savings and investment is caused by their cointegration over time rather than from capital immobility. Along this line of empirical analysis, more various econometric techniques have been used to examine the puzzle, including ARIMA[37], cointegration [38], ARDL bounds test[14, 25], cointegration with structural breaks [39], non-linear time series[34-35], panel cointegration [22, 24, 40], and the panel smooth transition approach[42]. Although the literature has applied various new and sophisticated econometric techniques, the examining results of the FH puzzle remain inconsistent.

Most related empirical studies in the literature focus on the FH puzzle in the OECD countries and developed countries, with papers rarely looking at developing countries: Kim et al. [42] for Asian countries and Ozmen [43] for Middle East and North African countries, to name just a few. Hence, this paper examines the FH puzzle in China and the ASEAN-5 countries to fill the gap in the literature. By considering the importance of time variation in the savings and investment nexus, we utilize recursive cointegration[26] to analyze the dynamic evolution of their long-run relationship in China and the ASEAN-5 countries.

## METHODOLOGY

### *The approach of Feldstein and Horioka [1]*

The FH approach entails an estimation of the following regression:

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

Here, I is gross domestic investment, S is gross domestic savings, and Y is gross domestic product. Coefficient  $\beta$ , which is the so-called savings retention coefficient, measures the degree of capital mobility. As Feldstein and Horioka [1] indicate, Equation (1) allows one to investigate the capital mobility hypothesis. If capital is perfectly mobile, then investors focus only on the rate of return on their investments and not on which country they invest in, implying that domestic savings could be unrelated to domestic investment under perfect international capital mobility. In such a case,  $\beta$  is expected to be around zero, suggesting that savings in each country move globally in response to international investing opportunities for higher profitability. On the other hand, domestic investment in a given country will be financed by the global pool of capital[1].

One can see conversely that if  $\beta$  is large and near to one in this model, then it means capital is immobile. Feldstein and Horioka [1] note that domestic savers are not able to readily avail themselves of all investment opportunities in other countries; hence, incremental savings will be invested in their original country. Furthermore, the greater this tendency is for domestic savings to flow only into domestic investment, the less mobile capital will be. These controversial results gave start to widespread debates in the economic literature. Many papers provide evidence confirming these results, while different findings exist in the literature with a wide array of interpretations. Therefore, the FH approach runs contrary to economic theory and is referred to as “the mother of all puzzles” [29].

### The recursive cointegration test

To reveal the dynamics of the relationship between savings and investment, we apply a procedure of the recursive cointegration test to assess the time-varying nature of integration. The recursive cointegration rank tests of Johansen [27-28] are used to examine the degree of cointegration during different sub-sample periods of our full sample. The Johansen tests are based on the following vector autoregressive (VAR) system:

$$\Delta Y_t = \sum_{i=1}^{k-1} \Gamma_i \Delta Y_{t-i} + \Pi Y_{t-1} + \varepsilon_t \quad t = 1, \dots, T$$

$$i = 1, \dots, k - 1$$

$$\Gamma_i = -I + \Pi_1 + \dots + \Pi_i \quad \Pi = -(I - \Pi_1 - \Pi_2 - \dots - \Pi_k) \quad (2)$$

Here,  $Y_t$  is a vector containing two variables: savings and capital. The related hypotheses have to do with the impact matrix  $\Pi$ ; if the rank of  $\Pi$  is  $r$ , where  $r \leq n-1$ , then  $r$  is the rank of cointegration. The matrix  $\Pi$  can be decomposed as  $\alpha\beta'$ , where  $\alpha$  is the matrix of the short-run adjustment coefficients to the cointegrating vectors (the  $\beta$  matrix).

There are two different test statistics for examining the rank of  $\Pi$ :

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^g \ln(1 - \hat{\lambda}_i) \quad (3)$$

$$\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \quad (4)$$

Here,  $\hat{\lambda}_i$  are the eigenvalues of the  $\Pi$  matrix and  $T$  is the number of observations. The first statistic of equation (3) is called the “trace” statistic, and the second statistic of equation (4) is called the “maximum eigenvalue” statistic. We employ the trace statistic of the recursive cointegration test to investigate the time-varying nature of convergence between savings and investment. If their relationship is cointegrating, then

the standardized trace statistics<sup>1</sup> should be greater than one, which means that we can reject the null hypothesis of no cointegration. On the contrary, if markets are not converging, then the standardized trace statistics should be less than one.

## EMPIRICAL RESULTS

This study’s empirical analysis covers China (CI) and the ASEAN-5 countries [Singapore (SG), Malaysia (MY), Thailand (TH), Indonesia (ID), and the Philippines (PH)], which are the original members of ASEAN and have the largest and most developed stock markets in ASEAN. Following the original study of Feldstein and Horioka [1], we define savings as gross domestic savings as a percentage of GDP, whereas investment is measured by gross fixed capital formation divided by GDP. The datasets come from International Financial Statistics (IFS) published by the International Monetary Fund (IMF) and Datastream by Thomson Reuters. The sample period runs from 1980 to 2011.

### Unit root test results

For studying the relationship of the time series of savings and investments in Chinese and the ASEAN-5, the first step is to test for a unit root type of non-stationarity. To test for stationarity, we use DF-GLS [44] to examine the presence of a unit root in these variables. Table 1 presents the results of the DF-GLS unit root tests for the time series of savings and investments. The numbers in parentheses are the lag order, selected on the basis of SC. The DF-GLS results of the model without trend confirm these two variables in all countries are I(1) at the 1% significant level.

<sup>1</sup> The standardized trace statistics are the ratio between the trace statistics and the corresponding 95% critical values.

**Table 1. Results of DF-GLS Unit Root**

Model	Savings		Investment	
	Without trends	With trends	Without trends	With trends
<i>Levels</i>				
China	-1.557 ( 1)	-3.125(1) **	0.020(0)	-3.360(1)**
Malaysia	-1.846(0)*	-2.537(0)	-1.295(0)	-2.334(1)
Singapore	-1.681(0)*	-2.116(0)	-0.594(0)	-3.358(1)**
Indonesia	-2.527(0)**	-3.287(0)**	-2.002(1)**	-2.348(1)
Thailand	-1.110(0)	-1.222(0)	-2.402(1)**	-2.579(1)*
Philippines	-2.340(0)**	-4.088(0)***	-1.780(0)*	-2.217(0)
<i>First differences</i>				
China	-6.266(0)***	-5.430(0)***	-3.657(0)***	-4.913(3)***
Malaysia	-5.760(0)***	-5.184(0)***	-3.659(0)***	-4.055(0)***
Singapore	-4.009(0)***	-4.168(0)***	-3.124(0)***	-3.386(0)**
Indonesia	-6.548(0)***	-6.076(1)***	-2.765(0)***	-3.166(0)**
Thailand	-4.617(0)***	-5.096(0)***	-3.166(0)***	-3.181(0)**
Philippines	-7.510(0)***	-4.991(2)***	-4.453(0)***	-4.480(0)***

Notes: \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% levels, respectively.

### RESULTS OF THE RECURSIVE STATISTICS

We apply recursive cointegration to examine the relationship between savings and domestic investment in China and the ASEAN-5 countries. The recursive cointegration test is from Hansen and Johansen[26], and the corresponding critical values are presented in Osterwald-Lenum [46]. If savings-investment correlations are cointegrated, then the standardized trace statistics should be consistently greater than one, implying that we can reject the null hypothesis of no cointegration. If the correlations are not cointegrated, then the standardized trace statistics will be less than one.

Figures 1 to 6 plot the scaled trace test statistics for the null hypotheses  $r \leq i, i = 0, 1$ . If the upper line in Figures 1 to 6, which shows the path of tests for  $\mathcal{H}(r \leq 0 | r = 1)$ , is over the 5% critical value, then it implies a recursive cointegration for savings and investment in these six countries. According to the results of Figures 1 to 6, the largest eigenvalue of the recursive trace statistics shows a decreasing trend, indicating a decreasing linkage between savings and investment in these six countries. All of these countries, except for Indonesia and the Philippines, present similar cointegrated patterns and do not support the cointegration relationship between the two variables since the early 1990s. According to the FH theory, this implies that the capital mobilities of these countries are high and domestic investment in them will be financed by the global pool of capital[1]. In other words, it shows that the capital markets in Singapore, Malaysia, Thailand, and China have a high degree of openness since the early 1990s.

As to Indonesia and the Philippines, the results of the recursive test of cointegration for their savings-

investment nexus in Figures 5 and 6 are different from Singapore, Malaysia, Thailand, and China. After 2001, the cointegration disappears in Indonesia and the Philippines, as illustrated in Figures 5 and 6. For the time period before 2001, Figures 5 and 6 show cointegration between savings and investment in these two countries and present that the capital mobilities in them are low, causing domestic investment to be financed by domestic savings. However, capital mobilities in Indonesia and the Philippines incur a structural change after 2001 - that is, their capital mobilities change from low to high, causing no cointegration to exist after 2001. In other words, Indonesia and the Philippines have highly mobile and open capital markets after 2001, and domestic investment could be financed from foreign countries. In Indonesia, the trace line exhibits a decreasing trend and is close to 1 around 2008, which implies that the degree of capital mobility became lower again around 2008.

The process of financial liberalization in China started late, during 1986-88. Although the degree of trade openness in China is not high, its government aggressively deregulated foreign investment, bringing into the country huge capital flows over the past 20 years. Reviewing ASEAN's economic development, foreign exchange controls as well as the ceilings on deposits and lending rates were removed at different paces during 1977-1985. Singapore (1975) and Malaysia (1978) were among the first countries to liberalize their interest rate controls, while the Philippines did not fully deregulate interest rates until the early 1980s. Ever since the 1997 Asian financial crisis, the Philippines, as with other East Asia's emerging economies, has to varying degrees embraced market-oriented financial reforms with an emphasis on fostering and opening its capital markets. However, the

opening up of its financial market has been intermittent and marked by relapses and backslidings. In fact, with little progress in recent years this country has a long way to go before reaching the level of Singapore. FDI flows into the Philippines related significantly in the early 2000s, but rebounded somewhat in 2005 and picked up in the following years, which can explain why its capital mobility was lower for a longer time until 2002.

Indonesia's economic system is less international and global than other ASEAN-5 countries, and its financial market is also smaller. Compared with average stock market indices globally in 2011, except for Indonesia, the other ASEAN-5 countries have market capitalizations as a percentage of GDP that are higher than the global average of 68.3%: 128.6% for

Singapore, 137.2% for Malaysia, 77.7% for Thailand, and 73.58% for the Philippines. The percentage for Indonesia is 46.1%, which is much lower than the global average. In the 1997 Asian financial crisis, Indonesia suffered from economic recession, depreciated currency, and political disorder. However, a remarkable upswing in Indonesia's economic growth took place after 2000, caused by several wide-ranging political and economic reforms that were implemented during the Asian financial crisis. Indonesia's government enacted incentive policies to attract foreign investment. Following these changes in Indonesia's economic and financial development, which caused capital mobility there to move from low to high, cointegration between savings and investment does not show up after 2001.

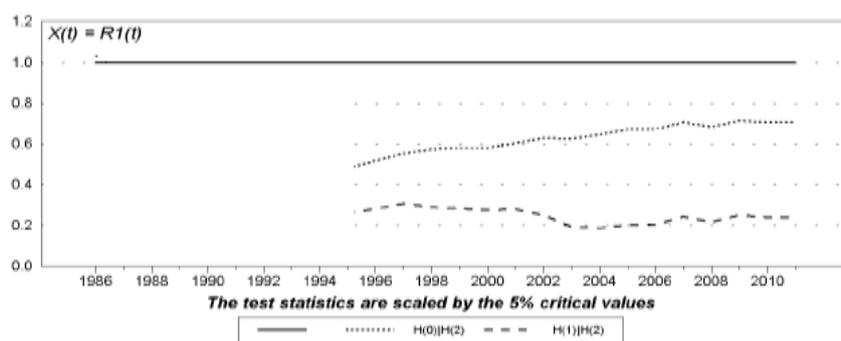


Fig-1: Recursive standardized trace statistics test of cointegration (China)

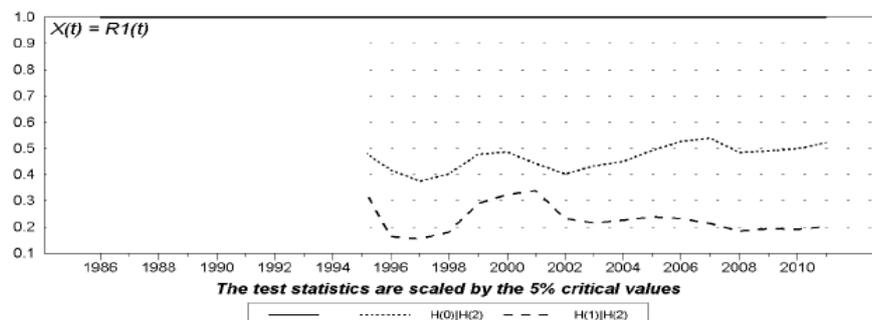


Fig-2: Recursive standardized trace statistics test of cointegration (Singapore)

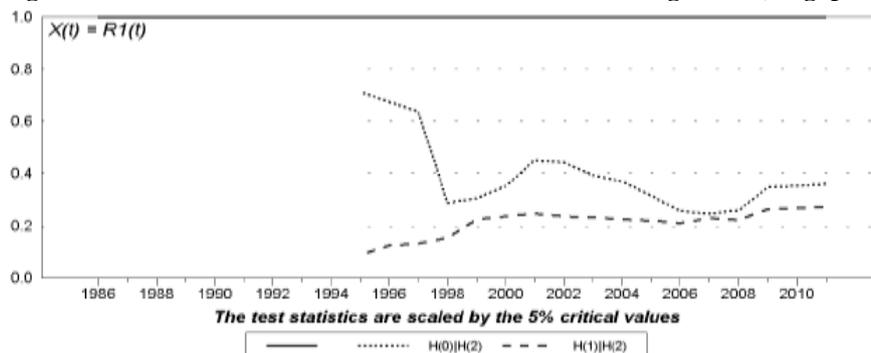


Fig-3: Recursive standardized trace statistics test of cointegration (Malaysia)

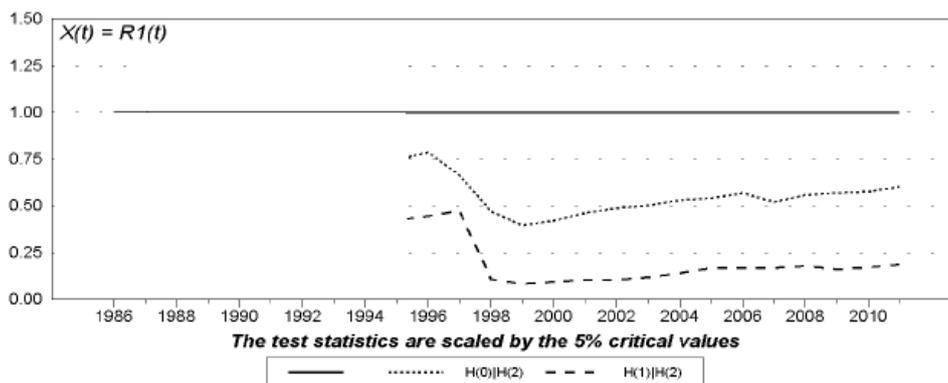


Fig-4: Recursive standardized trace statistics test of cointegration (Thailand)

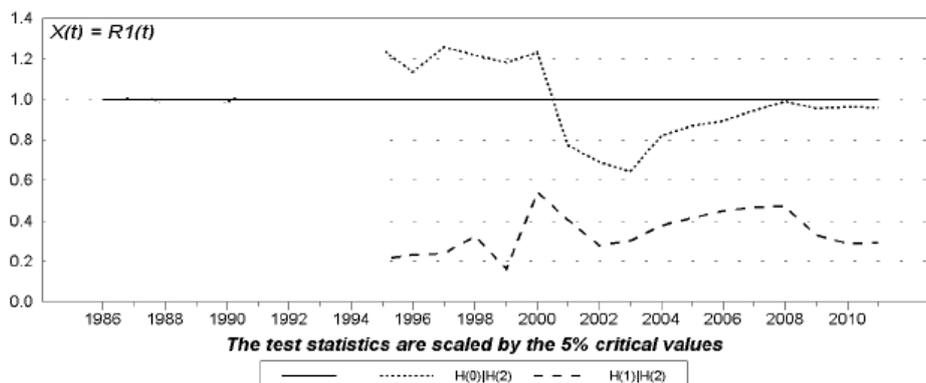


Fig-5: Recursive standardized trace statistics test of cointegration (Indonesia)

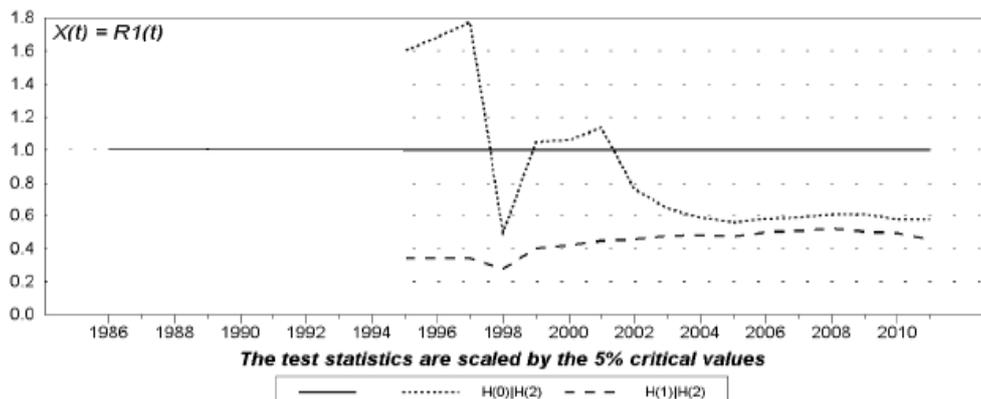


Fig-6: Recursive standardized trace statistics test of cointegration (Philippines)

**CONCLUSIONS**

This paper applies recursive cointegration analysis [26] to examine the dynamic changes in the Feldstein-Horioka[1] savings-investment (S-I) coefficients for China and the ASEAN-5 countries over time. Considering the implications of the time-varying behavior of these S-I linkages in the 6 countries, we employ recursive cointegration rank tests of Johansen [27-28] to trace the trends of the possible dynamic linkages in their capital markets.

To the extent that the S-I coefficients measure international capital mobility, the main empirical results

are as follows. The recursive trace statistics show that savings-investment linkages vary in these six countries. In fact, there is no cointegration between the two in four countries - China, Singapore, Malaysia, and Thailand - meaning that the mobility of their capital markets is high and domestic investment is financed by the global pool of capital. The other two countries, Indonesia and the Philippines, exhibit a cointegration between savings and investment before 2001. This indicates that they achieved highly mobile and open capital markets later, because to varying degrees they have embraced market-oriented financial reforms with an emphasis on

fostering and opening capital markets ever since the 1997 Asian financial crisis.

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