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THE FELDSTEIN-HORIOKA HYPOTHESIS AND INTERNATIONAL CAPITAL MOBILITY: AN EMPIRICAL INVESTIGATION FOR TURKEY

This empirical study is conducted to test the validity of the Feldstein-Horioka hypothesis for Turkey over the period 1960-2010 by means of fractional cointegration approach of Gil-Alana (2003) and Caporale and Gil-Alana (2004). According to the results, investment rate and savings rate series are fractionally cointegrated, supporting the validity of the Feldstein-Horioka hypothesis and low international capital mobility for Turkey.

Keywords: *investment rate; savings rate; Feldstein-Horioka hypothesis; capital mobility; fractional cointegration.*

Бурджу Кіран

ГІПОТЕЗА ФЕЛЬДШТЕЙНА-ХОРІОКИ І МОБІЛЬНІСТЬ МІЖНАРОДНОГО КАПІТАЛУ: ЕМПІРИЧНЕ ДОСЛІДЖЕННЯ НА ПРИКЛАДІ ТУРЕЧЧИНИ

У статті проведено емпіричне дослідження з метою перевірки правильності гіпотези Фельдштейна-Хоріоки відносно Туреччини за період з 1960 до 2010 року за допомогою підходу дробової коінтеграції Гіль-Алана (2003) і Капорале і Гіль-Алана (2004). Згідно з результатами, ряди рівня інвестицій і норми заощаджень дробово коінтегровані, що підтверджує дійсність гіпотези Фельдштейна-Хоріоки і низьку мобільність міжнародного капіталу для Туреччини.

Ключові слова: *інвестиційна ставка; норма заощаджень; гіпотеза Фельдштейна-Хоріоки; мобільність капіталу; дробова коінтеграція.*

Бурджу Киран

ГИПОТЕЗА ФЕЛЬДШТЕЙНА-ХОРИОКИ И МОБИЛЬНОСТЬ МЕЖДУНАРОДНОГО КАПИТАЛА: ЭМПИРИЧЕСКОЕ ИССЛЕДОВАНИЕ НА ПРИМЕРЕ ТУРЦИИ

В статье проведено эмпирическое исследование с целью проверки правильности гипотезы Фельдштейна-Хориоки относительно Турции за период с 1960 до 2010 года с помощью подхода дробной коинтеграции Гиль-Алана (2003) и Капорале и Гиль-Алана (2004). Согласно результатам, ряды уровня инвестиций и нормы сбережений дробно коинтегрированы, что подтверждает действительность гипотезы Фельдштейна-Хориоки и низкую мобильность международного капитала для Турции.

Ключевые слова: *инвестиционная ставка; норма сбережений; гипотеза Фельдштейна-Хориоки; мобильность капитала; дробная коинтеграция.*

1. Introduction. Since the seminal paper of Feldstein and Horioka (1980), the correlation between domestic savings and domestic investment and its implications for international capital mobility have been sharply debated in the literature as Feldstein-Horioka hypothesis. This hypothesis states a positive correlation between domestic savings and domestic investments and suggests that a high positive correlation between these variables implies low international capital mobility.

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Low international capital mobility means that domestic savings are being translated into domestic investments. In other words, if capital mobility is low, that will drive a wedge between domestic and foreign borrowing costs and domestic investment will be financed by domestic savings (Ghosh and Dutt, 2011, 29). Conversely, high capital mobility implies low conversation of domestic savings into domestic investments. This is because with high capital mobility, capital flows between countries equalize the yield of investors, hence it is not necessary for domestic savings and investments to be correlated (Christopoulos, 2007, 273). Savers face the same world interest rates and therefore could invest anywhere in the world.

The empirical findings of Feldstein and Horioka (1980) are supported by the studies including Feldstein (1983), Caprio and Howard (1984), Dooley et al. (1987), Summers (1988), Miller (1988), Feldstein and Bachetta (1989), Baxter and Crucini (1993), Agbetsiafa (2002), Adey (2003) and Coakley et al. (2003). On the other hand, some studies including Murphy (1984), Obstfeld (1986), Finn (1990), Stockman and Tesar (1991) and Barkoulas et al. (1996) disagree with the results of Feldstein and Horioka (1980). These studies differ in terms of econometric methodology, data sources, analyzed time period and countries under investigation.

The aim of this paper is to make a contribution to the existing literature on Feldstein-Horioka hypothesis by testing the relationship between domestic savings and domestic investment for Turkey over the period 1960-2010 within the fractional cointegration approach. Another paper which uses fractional cointegration approach for Feldstein-Horioka hypothesis is by Cooray and Sinha (2007). They investigated the relationship between savings and investment rates for 20 African countries by using semiparametric test of Geweke and Porter-Hudak (1983) for fractional cointegration. The difference of our paper is that we apply fractional cointegration approach introduced by Gil-Alana (2003) and Caporale and Gil-Alana (2004). Their approach is based on Robinson (1994) test which tests unit and fractional roots with a standard null limit distribution unaffected by inclusion or not of deterministic trends. To the best of our knowledge, there is no paper which uses the same approach to testing Feldstein-Horioka hypothesis (1980).

The rest of the paper is organized as follows: Section 2 provides a brief summary on Feldstein-Horioka hypothesis, Section 3 discusses the econometric methodology, Section 4 presents the data and the empirical results. Finally, the last section concludes.

2. The Model. In their paper, Feldstein and Horioka (1980) fit the following regression model for the relationship between domestic savings and domestic investment:

$$IR_t = \alpha + \beta SR_t + \varepsilon_t, \tag{2.1}$$

where IR is the domestic investment GDP ratio, SR is the domestic savings GDP ratio, β is the saving retention coefficient and ε is the error term. According to Feldstein and Horioka (1980), the coefficient β measures the degree of international capital mobility. The value of β lies between 0 and 1. If β=1, it means a 100% correlation between domestic savings and domestic investments (Ghosh and Dutt, 2011,

27). Large values of β indicate low capital mobility and small values of indicate high capital mobility. By using the data of 16 OECD countries over the period 1960-1974, Feldstein and Horioka conclude that domestic savings and domestic investments are highly correlated with a saving retention coefficient close to 1. On the econometric view, allowing for the stationarity properties of the series, valid economic inferences can be drawn only if equation (2.1) is a cointegrating relation (Christopoulos, 2007, 274). If *IR* and *SR* are cointegrated, that implies low capital mobility. The existence of a cointegration relationship between domestic savings and domestic investment could imply greater macroeconomic stability in economies as domestic investment is not dependent on foreign savings. Therefore, the influence of external forces on economies is smaller relative to those that rely on foreign savings to finance their investment. However, the lack of a cointegration relationship between domestic savings and domestic investment may cause macroeconomic instability (Cooray and Sinha, 2007, 1509).

3. Methodology. In this paper, Feldstein-Horioka hypothesis is investigated by means of fractional cointegration approach instead of traditional cointegration methods. The reason is that traditional cointegration methods assume all the variables to be integrated of order one, $I(1)$ and restrict error correction term be $I(0)$. When residuals are mean reverting but not $I(0)$, these methods have low power. The advantage of the fractional cointegration approach is that it allows residuals to be fractionally integrated rather than stationary. Following this way, we use fractional cointegration approach introduced by Gil-Alana (2003) and Caporale and Gil-Alana (2004) in our paper. Their approach is based on Robinson (1994) test which tests unit and fractional roots with a standard null limit distribution unaffected by inclusion or not of deterministic trends. At this point we give a brief description of Robinson test based on the following regression model:

$$y_t = \beta' z_t + x_t, \tag{3.1}$$

where y_t is the observed time series for $t=1,2,...T$, $\beta=(\beta_1,...,\beta_\kappa)$ ' is a $(k \times 1)$ vector of unknown parameters, z_t is a $(k \times 1)$ vector of deterministic regressors such as an intercept or a linear trend. The regression errors x_t can be explained as follows:

$$(1-L)^d x_t = u_t, \; t = 1,2,..., \tag{3.2}$$

where L is the lag operator and u_t is an $I(0)$ process. Here, d can take any real value. Robinson suggests a Lagrange multiplier (LM) test statistic for testing unit roots and other forms of nonstationary hypotheses, embedded in fractional alternatives. The main advantage of the procedure is that it tests unit and fractional roots with a standard null limit distribution. Under the null hypothesis H_0:d=d_0, the LM test statistics can be calculated as below:

$$\hat{r} = \frac{T^{1/2}}{\hat{\sigma}^2} \hat{A}^{-1/2} \hat{a}, \tag{3.3}$$

where T is the sample size and

$$\hat{a} = \frac{-2\pi}{T} \sum_{j=1}^{T-1} \psi(\lambda_j) g(\lambda_j; \hat{\theta})^{-1} I(\lambda_j); \; \hat{\sigma}^2 = \sigma^2(\hat{\theta}) = \frac{2\pi}{T} \sum_{j=1}^{T-1} g(\lambda_j; \hat{\theta})^{-1} I(\lambda_j);$$

$$\hat{A} = \frac{2}{T}\left(\sum_{j=1}^{T-1}\psi(\lambda_j)^2 - \sum_{j=1}^{T-1}\psi(\lambda_j)\hat{\xi}(\lambda_j)'\times\left(\sum_{j=1}^{T-1}\hat{\xi}(\lambda_j)\hat{\xi}(\lambda_j)'\right)^{-1}\times\sum_{j=1}^{T-1}\hat{\xi}(\lambda_j)\psi(\lambda_j)\right)$$

$$\psi(\lambda_j) = \log\left|2\sin\frac{\lambda_j}{2}\right|;\ \hat{\xi}(\lambda_j) = \frac{\partial}{\partial_\tau}\log g(\lambda_j;\hat{\xi}_j);\ \lambda_j = \frac{2\pi j}{T};\ \hat{\xi} = \arg\min_{\tau\in T^*}\sigma^2(\tau).$$

Here, $I(\lambda_j)$ is the periodogram of u_t and T^* is a compact subset or the Euclidean space. Robinson (1994) showed that the test statistics under certain regularity conditions is as follows:

$$\hat{\xi} \to_d N(0,1) \text{ as } T \to \infty. \quad (3.4)$$

Thus, a one sided 100% level test of the null hypothesis H_0:$d=d_0$ against the alternative H_0:$d>d_0$ is given by the rule "Reject H_0 if $\hat{\xi} > z_\alpha$". Conversely, a one sided 100α% level test of H_0:$d=d_0$ against the alternative H_0:$d<d_0$ is given by the rule "Reject H_0 if $\hat{\xi} < -z_\alpha$". Following these rules, Gil-Alana (2003) and Caporale and Gil-Alana (2004) suggest a fractional cointegration concept based on the following model:

$$(1-L)^{d+\theta}e_t = v_t,\ t=1,2,... \quad (3.5)$$

where e_t is the OLS residuals from the cointegrating regression and ν_t is $I(0)$. The null H0:θ=0 hypothesis is tested against the one sided alternative H0:θ<0. If H_0 hypothesis on the estimated residuals is rejected, there is an evidence of fractional cointegration of a certain degree since the residuals are integrated of a smaller order than the individual series. If we cannot reject the null hypothesis, it can be concluded that there is no evidence of fractional cointegration since the integration order of the residuals is the same as the univariate series.

4. Data and Empirical Results. This paper investigates the Feldstein-Horioka hypothesis for Turkey by using annual investment rate and savings rate series over the period 1960-2010. We define investment rate (IR) as investment divided by GDP and define savings rate (SR) as national savings divided by GDP. The gross fixed capital formation is used as the indicator for investment. The source of the data is World Bank's World Development Indicators database. The illustration of the series can be seen in Figure 1.

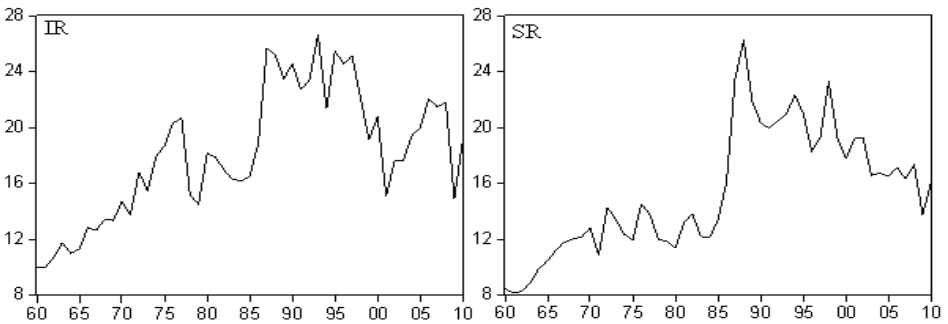

Figure 1. **Plots of the IR and SR series**

As can be seen from Figure 1, IR and SR series exhibit a nonstationary appearance with similar movements. Since the plots of the series are only suggestive of the relationship, we focus on this in the context of different techniques. First, it is examined whether the IR and SR series have a unit root. For this purpose, augmented Dickey-Fuller (ADF) and Philips and Perron (PP) unit root tests are applied and their results are in Table 1.

Table 1. **The results of ADF and PP unit root tests**

Variables	ADF	PP
IR	-2.696	-2.554
Δ IR	-9.141[a]	-9.379[a]
SR	-2.120	-2.017
Δ SR	-6.337[a]	-6.966[a]

[a] denotes that the unit root null hypothesis is rejected at the 1% significance level.

The results in Table 1 indicate that both IR and SR series are nonstationary in level but stationary at first differences. Since the concept of traditional unit root tests are too restrictive, we also test the unit root properties by performing Robinson (1994) test on the individual series. The results for the specifications with an intercept and a linear trend under the white noise assumption are reported in Table 2.

Table 2. **The results of Robinson test for unit root**

Variables	ADF	PP
IR	-2.696	-2.554
Δ IR	-9.141[a]	-9.379[a]
SR	-2.120	-2.017
Δ SR	-6.337[a]	-6.966[a]

[a] denotes that the unit root null hypothesis is rejected at the 1% significance level.

According to the obtained results, we cannot reject the unit root null hypothesis (d_0=1) for IR and SR series. After finding that the series have a unit root (I(1)), next we test whether there exists a long-run relationship between IR and SR series by using fractional cointegration approach. As reported before, the reason is that traditional cointegration methods which assume that all the variables are integrated of order one $I(1)$ and hence restrict the error correction term to be $I(0)$, have low power when the error correction term is mean reverting but not $I(0)$. The fractional cointegration approach allows residuals to be fractionally integrated rather than stationary. In our analysis, two steps are followed for fractional cointegration: first, the residuals (ε_t) are obtained from the following cointegrating regression:

$$IR_t = \alpha + \beta SR_t + \varepsilon_t, \qquad (2.1)$$

then, following Gil-Alana (2003) and Caporale and Gil-Alana (2004), Robinson (1994) test is applied on the mentioned residuals. Table 3 gives one-sided t-statistics for different values of d_0.

Table 3. **The results of Robinson test on the residuals**

d_0	Intercept	Trend
0.00	2.334	2.179
0.05	1.922	1.774
0.10	1.521[b]	1.381[b]
0.15	1.133[b]	1.003[b]
0.20	0.760[b]	0.641[b]

The End of *Table 3*

0.25	0.405[b]	0.297[b]
0.30	0.068[b]	-0.029[b]
0.35	-0.250[b]	-0.335[b]
0.40	-0.547[b]	-0.623[b]
0.45	-0.825[b]	-0.891[b]
0.50	-1.084[b]	-1.140[b]
0.55	-1.323[b]	-1.371[b]
0.60	-1.544[b]	-1.585[b]
0.65	-1.748	-1.782
0.70	-1.935	-1.963
0.75	-2.107	-2.129
0.80	-2.264	-2.282
0.85	-2.408	-2.422
0.90	-2.540	-2.550
0.95	-2.660	-2.667
1.00	-2.770	-2.774

[b] indicates nonrejection values of the null hypothesis at the 95% significance level.

It can be seen from Table 3 that the nonrejection values take place at d_0= 0.10, 0.15, 0.20, 0.25, 0.30, 0.35, 0.40, 0.45, 0.50, 0.55, 0.60 in both cases with an intercept and a linear trend. It is clear that unit root null hypothesis d_0=1 is rejected in both cases. This means that integration order of the residuals are smaller than one, in other words, residuals are mean reverting. These findings indicate the existence of fractional cointegration relationship between IR and SR series, supporting the validity of the Feldstein-Horioka hypothesis and low international capital mobility for Turkey.

5. Conclusions. In our paper, the validity of the Feldstein-Horioka hypothesis for Turkey is investigated over the period 1960-2010 by applying fractional cointegration approach of Gil-Alana (2003) and Caporale and Gil-Alana (2004). The reason for using fractional cointegration approach instead of traditional cointegration methods is that fractional cointegration approach allows residuals be fractionally integrated rather than stationary. The results of ADF and PP unit root tests applied on the investment rate and savings rate series show that both series are nonstationary in levels but stationary after first differencing. Since the concept of these unit root tests are too restrictive, we also apply Robinson (1994) test on the series for unit root properties and support that the unit root null hypothesis cannot be rejected. After finding that the series have the same integration order (I(1)), in the next step the fractional cointegration relationship between investment rate and savings rate is examined by obtaining residuals from the estimation of cointegrating regression and applying Robinson (1994) test on these residuals. According to the results, investment rate and savings rate series are fractionally cointegrated. The existence of fractional cointegration relationship between the mentioned series supports the validity of Feldstein-Horioka hypothesis and low international capital mobility for Turkey.

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