Revisiting the Feldstein-Horioka Puzzle for Turkey

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Abstract

The domestic saving and investment correlation as posited by Feldstein & Horioka (Feldstein & Horioka, 1980) is revisited for Turkey and tested over the periods 1950–2017, 1950–1989, and 1990–2017. The first period is characterized by restricted capital mobility and the second period represents a period of perfect capital mobility. The time series properties of the data and the presence of structural breaks are properly addressed when testing for the presence of a long-run relationship between investment and saving ratios by using the bounds testing procedure. We find saving and investments to be cointegrated for Turkey over the whole period and the sub-periods. However, the investments and savings are positively correlated during the period of restricted capital mobility (1950–1989) and negatively correlated during the period of perfect capital mobility (1990–2017). These results are in conformity with the Feldstein and Horioka hypothesis that in a closed economy domestic investments are financed with domestic savings, and under perfect international capital mobility domestic savings flow to the most attractive returns around the world.

Keywords: Feldstein-Horioka puzzle; Capital mobility; Turkey, Cointegration, Bounds testing procedure

1. Introduction

Feldstein and Horioka (1980) questioned whether a higher domestic saving rate in a country is correlated with a higher rate of domestic investment, not only to investigate international capital mobility but also to draw attention to an optimal savings policy and to the incidence of tax changes. For example, national savings policy depends on the pre-tax marginal product of capital in a closed economy, but depends on the after-tax return to investors in the case of perfect capital mobility. Therefore, international capital mobility is an important determinant of the optimal national savings policy. Likewise, international capital mobility has implications for the analysis of tax incidence. A tax on the income of all capital used in production is carried only by the capital owners under a closed economy, but by the domestic labour and foreign capital owners under a perfect capital mobility. Feldstein and Horioka (1980) measured the extent to which a higher domestic saving rate in a country correlated with a higher rate of domestic investment for the 21 OECD countries over the 1960–1974 period. They estimated the following equation in order to assess the relationship between investment and saving ratios:

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

where $\left(\frac{I}{Y}\right)_i$ denotes the ratio of gross domestic investment to gross domestic product and $\left(\frac{S}{Y}\right)_i$ is the ratio of gross domestic saving to gross domestic product in country *i*. The coefficient β is interpreted as the saving-retention coefficient and measures the degree of capital mobility. Under perfect capital mobility, the value of coefficient β would be close to zero, in contrast to a closed economy where the value of coefficient β would be close to one. Since the distribution of the incremental capital among countries varies inversely with the elasticity of the country's marginal product of capital, an increase in the saving rate in country i would spread investment uniformly over the world under perfect capital mobility. Therefore, under capital mobility there would not be a relationship between domestic saving and investments. Feldstein and Horioka (1980) find the estimate of β to be 0.89. The coefficients for each of the five-year sub-periods (0.85–0.95) are also found to be similar to the overall coefficient. The results also do not change even when they considered the potential endogeneity of the domestic saving, and sample selection bias. However, their results contradict the perfect international capital mobility hypothesis and suggest that most of the incremental saving remains in the country in which saving is done, and international capital flows do not respond to international differences in returns.

Feldstein and Horioka (1980) explain these contradictory results by saying that although liquid financial capital moves very rapidly to arbitrage short-term international differentials, long-term portfolio capital or direct investment is less mobile. This is because of uncertainties and risks associated with foreign investment, official restrictions, and high taxation on foreign investment, as well as institutional rigidities such as the saving institutions, insurance companies, and pension funds that deter foreign investment. In addition, foreign direct investments are linked to executing marketing strategies, employing production knowledge, or overcoming trade restrictions rather than to international yield differentials. However, it was still surprising to find a high correlation between domestic savings and investment among the OECD countries during the analysed period, during which financial market deregulations and easing of capital controls were in place. This contradiction produced the Feldstein-Horioka (FH) puzzle or paradox and has resulted in widespread debates and research in the economic literature (Apergis & Tsoumas, 2009; Obstfeld & Rogoff, 2000).

The FH puzzle has led to two parallel streams of literature. The first has tried to explain the high correlation between domestic saving and investments under perfect capital mobility with theoretical grounds and frictions such as the pro-cyclicality of saving and investment and the ability of a country to smooth its aggregate consumption over time; the efficiency of economic policy; the choice to target either domestic savings or investments; population growth; technological and demographic variables; the macroeconomic variables that determine economic growth; the failure of the real interest parity; capital controls; the validity of the current account solvency constraint; the government's reaction to current account imbalances; transaction costs in the financial sector and for international trade in goods; the 'home country bias' phenomenon; the presence of a non-traded consumption good; the degree of openness; foreign aid; country size; production, productivity, technological, global, trade, fiscal, growth, and other shocks; exchange rate regime changes; the impact of investors' protection law; balance mechanics and differentiation between 'saving' and 'financing'; the role of overseas balances; the necessity of the euro; the lack of information or asymmetric information costs; investors' risk aversion; political variables such as the role of democracy; higher risks of government interventions; the failure of financial market integration for long-term maturities; legal obstacles or tax impediments; limited enforcement and limited spanning; inefficient financial sectors, the development of the financial system, and its structure; and frictions in goods markets (Apergis and Tsoumas, 2009; Bai & Zhang, 2010; Baxter

& Crucini, 1993; Bayoumi, Sarno & Taylor, 1999; Beck, Demirgüç-Kunt & Levine, 2001; Blanchard & Giavazzi, 2001; Cardia, 1992; Coakley, Kulasi & Smith, 1996; Demirgüç-Kunt & Levine, 2001; Dooley, Frankel & Mathieson, 1987; Edwards, 2004; Feldstein, 1983; Feldstein, 1994; Ford & Horioka, 2017; Gunji, 2003; Hamada & Iwata, 1989; Ho, 2003; Ho & Huang, 2006; Isaksson, 2001; Kasuga, 2004; Lane & Milese-Feretti, 2001; Murphy, 1984; Nason & Rogers, 2002; Niehans, 1992; Obstfeld, 1986; Obstfeld, 1995; Obstfeld & Rogoff, 1995; Obstfeld & Rogoff, 2000; Olivei, 2000; Schmidt, 2016; Summers, 1988; Taylor, 1994; Watson, 2011; Wong, 1990).

A second stream of literature relates to an improper modelling of the saving and investment relationship for the explanation of the FH puzzle, as Feldstein and Horioka (1980) use cross-sectional and time-averaged data in order to eliminate the pro-cyclical nature of savings and investment. However, the Feldstein and Horioka (1980) methodology is criticized on a number of grounds: the FH sample period was very short to capture increases in capital mobility in the second half of the 1970s; time-averaged data in cross-sectional regressions overestimate or underestimate the true relationship; the nature of shocks and the structure of the economy for each country should have been taken into account; outliers, the choice of the time period, endogeneity, the regime changes, the omitted variables' bias, a constant in the regression, non-stationarity of variables in levels, and cointegration techniques; and short-run dynamics of the relationship between savings and investment should have been considered (Choudhry, Kling & Jayasekera, 2014; De Vita & Abbott, 2002; Dooley, Frankel & Mathieson, 1987; Ho, 2002; Jansen and Schultz, 1996; Katsimi & Zoega, 2016; Krol, 1996; Miller, 1988; Obstfeld, 1986, 1994; Sachs, 1981; Serletis & Gogas (2007); Sinn, 1992). Therefore, the saving-investment relationship for individual countries with time series analysis has been investigated to overcome the drawbacks of cross-sectional analysis such as sample selection bias, and the neglect of the country-specific saving-investment structure, structural changes, government policies, and country-specific shocks (e.g., De Vita & Abbott, 2002, and Miller, 1988 for the US; Jansen, 1996, Kejriwal, 2008, and Kumar & Bhaskara Rao, 2011 for the OECD countries individually; Ho, 2000 for Taiwan; Özmen & Parmaksiz, 2003, and Sarno & Taylor, 1998 for the UK; Mastroyiannis, 2007, and Pelagidis & Mastroyiannis, 2003 for Greece; Sinha & Sinha, 2004 for 123 countries individually; Narayan, 2005, and Yildirim & Orman, 2017 for China; Ketenci, 2012, and Telatar, Telatar & Bolatoglu, 2007 for EU countries individually; Marinheiro, 2008 for Egypt; Narayan & Narayan, 2010 for G7 countries individually;

Verma & Saleh, 2011 for Saudi Arabia; Bagheri, Keshtkaran & Hazrati, 2012 for Iran; Khan & Saeed, 2012 for Pakistan; and Slimane, Tahar, & Essid, 2013 for Tunisia and Morocco). Panel techniques have been used in another group of studies, but they reached similar conclusions to the time series approaches (Adedeji & Thornton, 2006; Coakley, Fuertes, & Spagnolo, 2004; Ho, 2002; Krol, 1996; Younas, 2007). The results from the panel studies point out that the cointegration tests are valid only when structural breaks or regime changes are taken into account. For example, Westerlund (2006) finds that savings and investment are cointegrated under the presence of breaks in their levels.

Similarly, many studies have investigated the FH puzzle for Turkey, and these studies find a saving-retention coefficient to vary between 0.16 to almost one, depending on the econometric method used, time period and data frequency, and whether structural breaks are taken into account (see Appendix A). The general conclusion from the studies in Appendix A is that there is a cointegration or a long-run relationship between domestic saving and investments in Turkey, and this relationship weakens in the recent period with more integration to global financial markets. However, time series analysis and cointegration approaches to the FH puzzle have created more confusion than clarification, since the results are very sensitive as to whether the saving and investment series are treated as stationary, I(0), or non-stationary, I(1), and whether the structural breaks in the series and in the cointegration relationships are taken into account. Indeed, Balotoğlu (2005), Kaya (2010), İyidoğan and Balıkçıoğlu (2010), Esen, Yıldırım, & Kostakoglu (2012), and Altunöz (2014) find saving and investment series to be I(1) according to the (Augmented) Dickey Fuller test (Dickey & Fuller, 1979, 1981) and the Philips and Perron test (Philips & Perron, 1988), but I(0) according to the KPSS test (Kwiatkowsky, Philips, Schmidt, & Shin, 1992). Therefore, they adopt the bound-testing procedure that can be applied irrespective of whether regressors are purely I(0), purely I(1), or mutually cointegrated (Pesaran, Shin, & Smith, 2001). Altıntaş and Taban (2011), Mangır and Ertuğrul (2012), Erdem, Köseoğlu, and Yücel (2016), Karabulut, Ekinci, and Tüzün (2017), Çağlar and Yavuz (2018), and Yıldırım and Koska (2018) suggest that the failure to account for the presence of structural breaks in the series leads to spurious findings of high correlation between savings and investments. Therefore, they perform unit root tests in the presence of structural breaks (e.g., Carrion-i-Silvestre, Kim, & Perron, 2009; Lee & Strazicich, 2003, 2004, 2013; Lumsdaine & Papell, 1995; Zivot & Andrews, 1992) in the saving and investment series and find saving and investment series to be 1(1) with the breaks. In addition, Dursun and Abasız (2014), Erdem, Köseoğlu, and Yücel (2016), Karabulut, Ekinci, and Tüzün (2017), and Çağlar and Yavuz (2018) allow for single and multiple breaks in the cointegration relationship and find that the saving-retention coefficient gets smaller when multiple breaks are considered. Similarly, the application of the Kalman filter technique using a time-varying parameter approach and the Markov regime switching model by Mangır and Ertuğrul (2012), Demir and Cengibozan (2017), and Yıldırım and Koska (2018) show that the saving-retention coefficient gets smaller over the recent period.

In this article, the bounds-testing approach to cointegration (Pesaran et al., 2001) is adopted, and several features of our approach are worth emphasizing. First, consistent with the critics of Feldstein and Horioka (1980) that capital mobility is not a short-run phenomenon, we use the longest time-series data on saving and investment rates at the annual frequency for Turkey for the period covering 1950 until 2017. The period in question spans about seven decades, allowing us to focus on a truly long-run relationship between saving and investment rates in Turkey.

Second, the structural breaks are most likely to occur in our data series, as it covers almost seven decades that witnessed the economic and financial crisis, economic and financial integration, and policy changes; the military coups in the early 1960s, 1970s, and 1980s; and global financial crises in the late 1990s and 2000s. We accommodate these structural breaks by means of impulse dummies.

Third, we test the existence of a long-run relationship between saving and investment rates in Turkey by applying the bounds-testing procedure of Pesaran et al. (2001). The advantage of using this approach is that it can be performed in cases when regressors are I(1), I(0), or mutually cointegrated. In addition, this procedure captures the data-generating process with a sufficient number of lags in a general-to-specific modelling approach, and a dynamic error correction model (ECM) can be derived from a simple linear transformation. Furthermore, the procedure is based on an unrestricted error-correction model, which allows for the joint estimation of long- as well as short-run effects. As argued by Banerjee, Dolado, and Mestre (1998), joint estimation has better statistical properties than the two-step Engle–Granger procedure that pushes the short-run dynamics into the error term. In addition, the use of the procedure of Pesaran et al. (2001) is suitable in the current context because there is no uniform agreement in the literature so far on whether Turkish saving and investment rates are an I(1) or I(0) process.

Finally, we ensure that the diagnostic tests of the final model are satisfactory and the model passes the stability tests that are ignored in previous studies in the application of the Pesaran et al. (2001) procedure to the saving and investment relationship in Turkey.

Our main finding is that there is the existence of a long-run relationship between saving and investment rates in Turkey over the whole period. This relationship is positive over the first period (1950–1989) and negative over the second period (1990–2017). Our finding is in contrast to that reported in other studies (Appendix A) that also employ the bounds-testing procedure. The differences between our findings and the results in other studies can be explained by several factors. We address the relationship between saving and investment rates using a much longer sample of data; we properly account for the presence of structural breaks; and the bounds-testing procedure is applied to two sub-periods (1950–1989 and 1990–2017) and to the overall sample period (1950–2017). The 1950–1989 period is characterized by a relatively low degree of international capital mobility and high financial restrictions, whereas the 1990–2017 period is typified by a high degree of capital mobility.

The remainder of the paper is organized as follows. Section 2 discusses the description of data and their sources, Section 3 describes the bounds-testing procedure, Section 4 reports estimation results, and Section 5 concludes.

2. Data

Gross fixed investments as a share of GDP and total domestic savings as a share of GDP are used as indicators of domestic investments and savings in Turkey, respectively. The data are annual and cover the period 1950–2017. The data come from various sources and are compiled by the author from the following sources: The Turkish Statistical Institute, the State Planning Organisation, the Five Year Development Plans, the World Development Indicators of the World Bank, and from Gürtan (1959) and Korum (1969) for the early period. There have been several revisions to the series, with major revisions in 1998 and 2011.

In sequel, we will denote the investment and saving ratios as $\left(\frac{I}{Y}\right)_t$ and $\left(\frac{S}{Y}\right)_t$, and the changes in these ratios are denoted as $\Delta\left(\frac{I}{Y}\right)_t$ and $\Delta\left(\frac{S}{Y}\right)_t$, respectively. Both investment and saving ratios and the corresponding first differences are displayed in Figure 1.

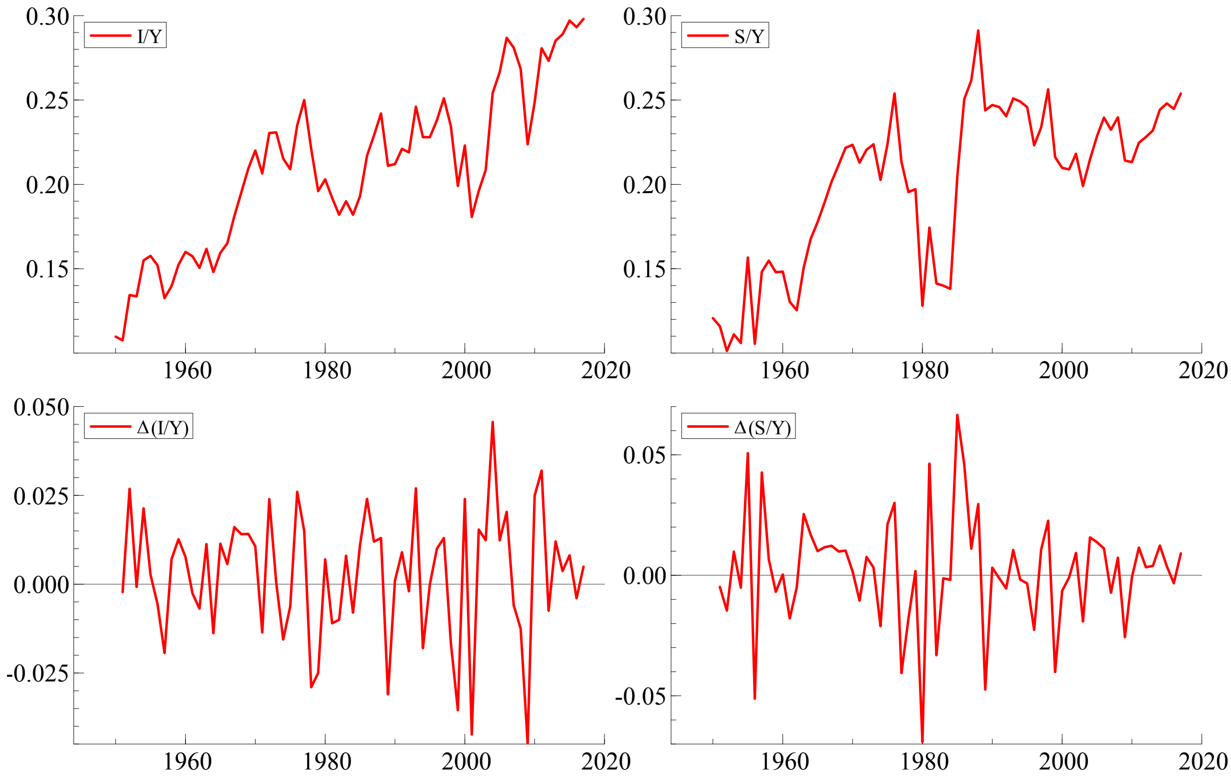

Figure 1. Actual data: investment and saving ratios and the changes in these ratios

The overall impression from Figure 1 is that there are certain common features shared by the two ratios in the early period: they both have an increasing trend until the late 1970s, then a decreasing trend in the early 1980s, and then a stepwise increase in the mid-1980s. However, the decrease and the increase in the saving ratio in the 1980s are more pronounced than the investment ratio. In addition, different dynamics in investment and saving ratios are observed in the 1990s: a stable investment ratio, but a declining saving ratio. Both series decrease in the early 2000s and increase until the late 2000s; however, this time the decrease and increase in investment ratio are sharper than the saving ratio. They both again decrease in the late 2000s and then show an increasing trend afterwards; again the decrease in the late 2000s and the increase afterwards are more pronounced in the investment ratio than in the saving ratio. The similar differences before and after the 1990 period are also observed in the changes of the series. The two lower panels in Figure 1 present the changes of investment and saving ratios, which look quite similar aside from the observation that the changes in the investment ratio are more volatile in the 2000s than the changes in the saving ratio, and the changes in the saving ratio are more volatile in the late 1950s and in the 1980s than the changes in the investment ratio. A spike in the changes of the investment and saving ratios during these periods corresponds to a stepwise shift in the levels of investment and saving ratios. In light of the visual inspection, we can say that investment and saving ratios tend to move together with a sharp decrease and increase in the investment ratio in the 1980s and a sharp decrease and increase in the saving ratio in the 2000s. In addition, investment ratios have been higher than saving ratios since the mid-2000s. However, the similarities and differences in the series observed by visual inspection need to be confirmed by the application of formal statistical methods.

3. Methodology

Since there is uncertainty about the order of integration for the Turkish investment and saving ratios, the cointegration between investment and savings is analysed by means of a bounds-testing procedure developed by Pesaran et al. (2001), which is applicable whether regressors are purely I(0), purely I(1), or mutually cointegrated.

We model Equation 1 as a VAR model of order p, which is further reduced to the following conditional ECM in order to implement the bounds procedure:

$$\Delta\left(\frac{I}{Y}\right)_t = \alpha + \theta_1\left(\frac{I}{Y}\right)_{t-1} + \theta_2\left(\frac{S}{Y}\right)_{t-1} + \sum_{i=1}^{p}\gamma_i\Delta\left(\frac{I}{Y}\right)_{t-i} + \sum_{j=0}^{p}\delta_j\Delta\left(\frac{S}{Y}\right)_{t-j} + \omega' D_t + \varepsilon_t \qquad (2)$$

The lagged values of $\left(\frac{I}{Y}\right)_t$ and $\left(\frac{S}{Y}\right)_t$ constitute a long-run relationship. The deterministic terms such as a constant and dummy variables are given by α and D_t, respectively. The short-run dynamics are captured by means of lagged values of $\Delta\left(\frac{I}{Y}\right)_t$ and current and lagged values of $\Delta\left(\frac{S}{Y}\right)_t$. The conditional long-run elasticities of investment ratio with respect to saving ratio is given by $-\theta_2/\theta_1$ (Banerjee et al., 1998). The examination of evidence for a long-run relationship between investment and savings is conducted by using an F-test. The F-test statistic tests the joint significance of the coefficients on the one period lagged levels of investment and saving ratios in Equation 2. That is, $H_0 = \theta_1 = \theta_2 = 0.$ However, this statistic has a nonstandard distribution that depends upon: (i) the order of integration of the regressors, (ii) the number of regressors, (iii) an intercept and/or trend included in the model, and (iv) sample size. Pesaran et al. (2001) provide two sets of asymptotic critical values that are critical value bounds for all classifications of the regressors as purely I(1), I(0), or mutually cointegrated. However, given the relatively small sample size in the present study (68 for the whole sample, and 40 and 28 for the subsamples), critical values are based on Narayan (2005), which are specific to the sample size.

There are two sets of critical values for a given significance level, with and without a time trend. The lower bound assumes that all regressors are I(0), and the upper bound assumes that all regressors are I(1). If the calculated F-statistic falls below the lower bound, we cannot reject the null hypothesis of no cointegration between investment and savings. Conversely, if the F-statistic exceeds the upper bound, we can conclude that a long-run relationship between investment and savings in Turkey exists. Finally, if the F-statistic falls within the critical bounds, the order of integration of the variables must be investigated in order to obtain conclusive inference.

The estimates of $\theta_1 - \theta_2$ are used to form an error-correction term (ECT) in order to determine whether the adjustment of investment and savings is toward their long-run equilibrium values. Therefore, lagged-level investment and saving ratios in Equation (2) are replaced by ECT_{t-1} in order to form the conditional ECM:

$$\Delta\left(\frac{I}{Y}\right)_t = \alpha + \mu ECT_{t-1} + \sum_{i=1}^{p}\gamma_i\Delta\left(\frac{I}{Y}\right)_{t-i} + \sum_{j=1}^{p}\delta_j\Delta\left(\frac{S}{Y}\right)_{t-j} + \omega' D_t + \varepsilon_t \qquad (3)$$

A negative and significant estimation of μ represents the speed of adjustment as well as an alternative way of supporting cointegration between investment and saving ratios.

4. Estimations

The first step in the bounds-testing procedure is to determine the appropriate lag structure through the selection criterion and Lagrange Multiplier (LM) statistics. The results of the lag order *p* selection procedure for Equation 2 are shown in Table 2. The information criteria (Akaike, AIC, and Schwarz, SIC) and the LM statistical testing for the remaining autocorrelation up to the first and second orders in regression residuals are provided. Akaike information criteria (AIC) selects the lag length *p = 2*, whereas the Schwarz information criteria (SIC) selects the lag length *p = 1* for the whole period (1950–2017). Since none of the lags suffer from serial correlation as indicated by LM statistics, the model with *p = 1* is preferred for the whole period. Both information criteria—AIC and SIC—select *p = 2* for the first period (1950–1989). For all three values of *p*, there is no evidence of remaining autocorrelation in the regression residuals. Given the evidence from the selection criteria and the evidence of no residual autocorrelation regardless of the value of *p*, the model with *p = 2* is chosen for the first period. AIC selects the lag length *p = 2*, whereas SIC selects the lag length *p = 1* for the second period (1990–2017). However, the lags suffer from serial correlation as indicated by LM statistics for the models with *p = 1* and *p = 2*; therefore the model with *p = 3* is preferred for the second period.

Several dummies have been included in the test regressions to account for the presence of outliers corresponding to the periods of unusually large discrepancies between investment and savings ratios. These dummies for each period are also reported in Table 1.

Table 1: Lag order selection for the periods, 1950-2017, 1950-1989, and 1990-2017

1950-2017				
P	**AIC**	**SIC**	$\chi^2_{SC}(1)$	$\chi^2_{SC}(2)$
1	-5.843	**-5.445**	**0.889**	**0.378**
2	**-5.911**	-5.410	0.417	0.712
3	-5.629	-5.281	0.395	0.696
Dummies for 1954, 1979, 1989, 1999, 2001, 2004, 2006, 2009, and 2011 depending on the lag length				
1950-1989				
P	**AIC**	**SIC**	$\chi^2_{SC}(1)$	$\chi^2_{SC}(2)$
1	-6.072	-5.857	0.560	0.613
2	**-6.732**	**-6.253**	**0.470**	**0.144**
3	-6.663	-6.135	0.992	0.994
Dummies for 1954, 1964, 1972, 1973, 1983, and 1989 depending on the lag length				
1990-2017				
P	**AIC**	**SIC**	$\chi^2_{SC}(1)$	$\chi^2_{SC}(2)$
1	-5.854	**-5.426**	0.016	0.007
2	**-5.925**	-5.401	0.089	0.088
3	-5.870	-5.252	**0.353**	**0.088**
Dummies for 1996, 1998, 2001, and 2009 depending on the lag length				

Notes: *p* is the lag order of the underlying VAR model for the conditional ECM, see Equation 2. AIC and SIC are the Akaike and Schwarz Information Criteria, respectively. $\chi^2_{SC}(1)$ and $\chi^2_{SC}(2)$ are the *p*-values of the Lagrange multiplier test statistics for testing for residual autocorrelation of orders up to 1 and 2, respectively.

The second step of the bounds procedure is to compare the computed F-statistics for the conditional ECM to the lower and upper bounds corresponding to case III in Pesaran et al. (2001), i.e., with unrestricted constant and no linear deterministic trend for cointegration. The F-test statistics for the joint null hypothesis $H_0 = \theta_1 = \theta_2 = 0$ using the finite-sample critical values from Narayan (2005) for T = 30, T = 35, T = 40, T = 65, and T = 70 corresponding to case III in Pesaran et al. (2001), i.e., with unrestricted constant and no linear deterministic trend and with 1%, 5%, and 10% critical values, are given in Table 2. F-statistics for estimated conditional ECM are given for the three periods for $p = 1$, $p = 2$, and $p = 3$ in Table 3.

Table 2: Bounds test for cointegration: Critical value bounds of the F-statistic with unrestricted constant and no linear deterministic trend

1%	**p=1**		**p=2**		**p=3**		**5%**	**p=1**		**p=2**		**p=3**	
T	**I(0)**	**I(1)**	**I(0)**	**I(1)**	**I(0)**	**I(1)**	**T**	**I(0)**	**I(1)**	**I(0)**	**I(1)**	**I(0)**	**I(1)**
30	8.170	9.285	6.183	7.873	5.333	7.063	**30**	5.395	6.350	4.267	5.473	3.710	5.018
35	7.870	8.960	6.140	7.607	5.198	6.845	**35**	5.290	6.175	4.183	5.333	3.615	4.913
40	7.625	8.825	5.893	7.337	5.018	6.610	**40**	5.260	6.160	4.133	5.260	3.548	4.803
65	7.320	8.425	5.583	6.853	4.690	6.143	**65**	5.130	5.980	4.010	5.080	3.435	4.583
70	7.170	8.405	5.487	6.880	4.635	6.055	**70**	5.055	5.915	3.947	5.020	3.370	4.545

10%	p=1		p=2		p=3								
T	**I(0)**	**I(1)**	**I(0)**	**I(1)**	**I(0)**	**I(1)**							
30	4.290	5.080	3.437	4.470	3.008	4.150							
35	4.225	5.050	3.393	4.410	2.958	4.100							
40	4.235	5.000	3.373	4.377	2.933	4.020							
65	4.175	4.930	3.300	4.250	2.843	3.923							
70	4.125	4.880	3.250	4.237	2.818	3.880							

Notes: Narayan (2005), page 1988.

Table 3: Calculated F-statistics for bounds tests

p	Period	$F^{III}_{H_0:\,\theta_1=\theta_2=0}$	p	Period	$F^{III}_{H_0:\,\theta_1=\theta_2=0}$	p	Period	$F^{III}_{H_0:\,\theta_1=\theta_2=0}$
1	**1952-2017**	**6.013****	1	1952-1989	14.180***	1	1992-2017	6.880**
2	1953-2017	3.134	**2**	**1953-1989**	**9.745*****	2	1993-2017	7.565**
3	1954-2017	2.968	3	1954-1989	29.082***	**3**	**1994-2017**	**6.638****

Notes: $F^{III}_{H_0:\,\theta_1=\theta_2=0}$ denotes the F-test statistics for the null hypothesis $H_0: \theta_1 = \theta_2 = 0$ using the finite-sample critical values reported in Narayan (2005, page 1988) for T = 30, 35, 40, 65, and 70 corresponding to case III in Pesaran et al. (2001), i.e. with unrestricted constant and no linear deterministic trend (in Table 2 above). In Table 3, '***' indicates that the null hypothesis of interest can be rejected at the 1% significance level, '**' indicates that the null hypothesis of interest can be rejected at the 5% significance level, '*' indicates that the null hypothesis of interest can be rejected at the 10% significance level, and 'no stars' indicates that there is no cointegration between the variables of interest.

As seen, the null hypothesis of no long-run relationship between investment and saving ratios can be rejected for $p = 1$ for the whole period at the 5% significance level; for all p values for the first period at the 1% significance level; and for all p values for the second period at the 5% significance level. Given the results and evidence from information criteria and lag order selection in Table 1, the model with $p = 1$ is preferred for the whole period, indicating that there is a long-run relationship between investment and saving ratios at the 5% significance level; the model with $p = 2$ is chosen for the first period, accepting the cointegration between investment and saving ratios at the 1% significance level; and the model with $p = 3$ is chosen for the second period, confirming a long-run relationship between investment and saving ratios at the 5% significance level.

The third step of the bounds-testing procedure after establishing a long-run relationship between variables of interest is to estimate the coefficients of interest. We start with the error correction model of $p = 1$ for the whole period (1950–2017), and after deleting the insignificant augmentation lags, we obtain the following parsimonious model (SEs are in parentheses and error probabilities are in brackets):

$$\Delta\left(\frac{I}{Y}\right)_t = \underset{(0.007)}{0.007} + \underset{(0.072)}{0.123}\Delta\left(\frac{S}{Y}\right)_t - \underset{(0.057)}{0.206}\left(\frac{I}{Y}\right)_{t-1} + \underset{(0.059)}{0.204}\left(\frac{S}{Y}\right)_{t-1} - \underset{(0.012)}{0.026D1979_t}$$

$$- \underset{(0.013)}{0.041D1989_t} - \underset{(0.013)}{0.041D1999_t} - \underset{(0.012)}{0.046D2001_t} + \underset{(0.012)}{0.040D2004_t} - \underset{(0.013)}{0.042D2009_t}$$

$$+ \underset{(0.012)}{0.032 D2011_t} + \varepsilon_t \qquad (4)$$

$R^2 = 0.610$, $F_{(10,56)} = 8.740[0.000]$, T = 67

$F_{(2,54)}^{AR(1-2)} = 1.434[0.247]$, $F_{(1,65)}^{ARCH(1)} = 1.334[0.252]$, $\chi_{(2)}^{Norm} = 0.814[0.666]$,

$F_{(6,53)}^{Hetero} = 0.424[0.860]$, $F_{(2,54)}^{RESET23} = 0.107[0.898]$

The parsimonious model passes the standard specification tests (e.g., tests of no residual autocorrelation, of no residual ARCH effects, of residual normality, and of no residual heteroscedasticity and the RESET test for functional form misspecification). The outliers have been identified as those residuals exceeding regression SE by a factor of 2 in the estimated regression (4) with $p = 1$ without intervention dummies. Therefore, several dummies are added to take into account these breaks: the dummy for the year 1979 justifies the 1979 economic crises; a dummy for the year 1989 accounts for the start of the full capital account liberalization; the dummy for the year 1999 construes the devastating earthquake of August 1999 in north-western Turkey together with the impacts of the 1997 Asian and 1998 Russian and Brazilian financial crises; the dummy for the year 2001 explains the 2001 Turkish banking and currency crisis; the dummy for the year 2004 presents the year in which the current account started to exceed 4% of GDP; the dummy for the year 2009 reveals the 2008–2009 global financial crisis; and a dummy for the year 2011 is for the data revisions in that year.

According to Equation (4), the long-run elasticities of investment ratio with respect to saving ratio is $(-\theta_2/\theta_1 = -(0.204/-0.206)) = 0.99$. An increase of 1% in the saving ratio increases the investment ratio almost by 1%. This is a very large effect and is consistent with the FH puzzle given the capital market liberalization since 1989.

The estimated model (Equation 4) allows us to compare the coefficients belonging to the lagged investment and saving ratios. These coefficients are of a similar absolute magnitude with the implied long-run vector of (1, –0.99)′ such that one can safely impose a homogeneity restriction $\theta_1 = -\theta_2$, i.e., the long-run relationship vector between investment and saving ratios is $(1,\ -1)'$. The restricted ECM is given below:

$$\Delta\left(\frac{I}{Y}\right)_t = 0.006 + 0.124\Delta\left(\frac{S}{Y}\right)_t - 0.205\left(\frac{I}{Y} - \frac{S}{Y}\right)_{t-1} - 0.026D1979_t - 0.041D1989_t$$

(0.002) (0.071) (0.054) (0.012) (0.013)

$$-0.042D1999_t - 0.046D2001_t + 0.040D2004_t - 0.042D2009_t + 0.032D2011_t + \varepsilon_t$$
(0.013) (0.012) (0.012) (0.013) (0.012) (5)

$R^2 = 0.610$, $F_{(9,57)} = 9.883[0.000]$, T = 67

$F_{(2,55)}^{AR(1-2)} = 1.410[0.253]$, $F_{(1,65)}^{ARCH(1)} = 1.360[0.248]$, $\chi_{(2)}^{Norm} = 0.826[0.662]$,

$F_{(4,54)}^{Hetero} = 2.003[0.093]$, $F_{(2,55)}^{RESET23} = 0.115[0.892]$

The homogeneity restriction in Equation 5 does not make any difference in the estimated coefficients apart from the constant, which becomes significant. All retained coefficients, especially the impulse dummies, are estimated with a high degree of precision. In addition, the long-run relationship is highly significant in the restricted ECM. These results are also consistent with the close match between the actual and the fitted values displayed in the left-top panel of Figure 2; the corresponding cross-plot shown in the right-top panel; and the estimated regression residuals and their autocorrelation function up to the ninth order reported in the left- and right-bottom panels, respectively. In addition, the values of the one-step, breakpoint, and forecast Chow test statistics scaled by their respective 1% critical values in Figure 3 do not show any signs of model instability. The graphics, regression output, and residual diagnostic and Chow tests were all calculated using Oxmetrics 7.10 (see Hendry and Doornik, 2013).

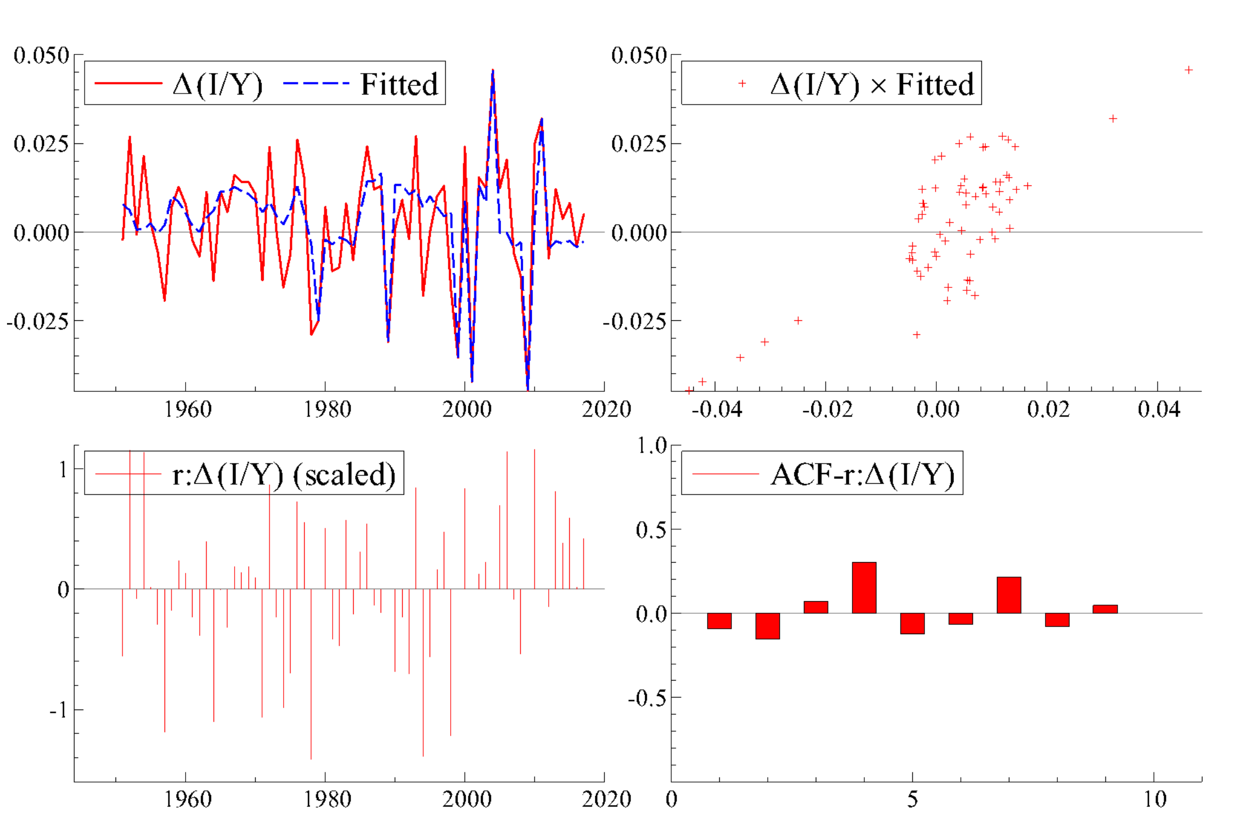

Figure 2. Actual and fitted values; cross-plot of actual and fitted values; regression residuals (r:Δ(I/Y)); autocorrelation function of regression residuals (ACF-r:Δ(I/Y)) – (1950-2017)

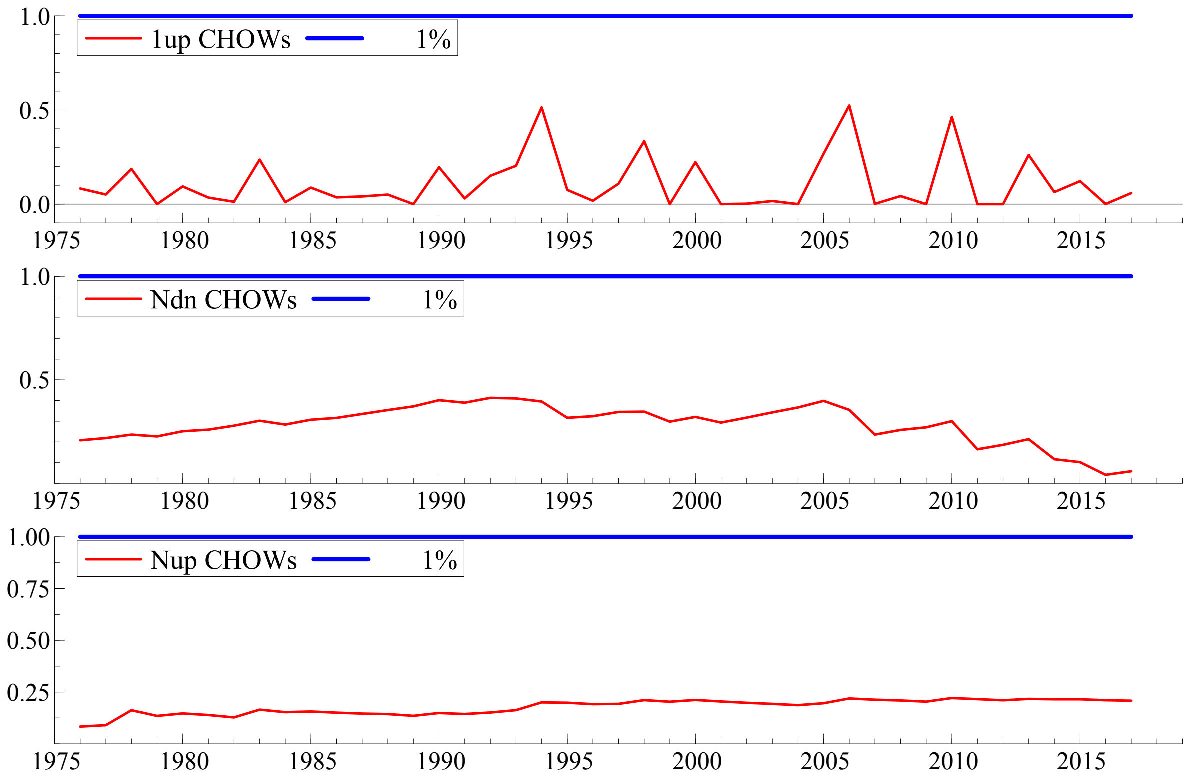

Figure 3. Recursive stability one-step, breakpoint and forecast Chow test statistics scaled by their respective 1% critical values – (1950-2017)

As shown in Equation 4, the long-run coefficient of the saving ratio with respect to the investment ratio or the saving-retention coefficient of the FH hypothesis (Feldstein & Horioka, 1980) for the whole period is 0.99. However, the graphs for the investment and saving ratios in Figure 1 show differences in the investment-saving relationship before and after the capital market liberalization that started in 1989. Therefore, we employ the bounds procedure for the first period (1950–1989) and also for the second period (1990–2017) to see whether the saving-retention coefficients are similar in both periods.

For the first period (1950–1989), both information criteria (AIC and SIC) select $p = 2$, and there is no evidence of remaining autocorrelation in the regression residuals for all values of p in Table 1. In addition, the null hypothesis of no long-run relationship between investment and saving ratios is decisively rejected for all values of p at the 1% significance level. Given the evidence from the selection criteria and the evidence of no residual autocorrelation regardless of the value of p, the model with $p = 2$ is chosen for the first period. We start with the error correction model of $p = 2$ for the first period (1950–1989), again delete the insignificant augmentation lags, and obtain the following parsimonious model:

$$\Delta\left(\frac{I}{Y}\right)_t = \underset{(0.008)}{0.012} - \underset{(0.095)}{0.331}\Delta\left(\frac{I}{Y}\right)_{t-2} + \underset{(0.050)}{0.190}\Delta\left(\frac{S}{Y}\right)_t + \underset{(0.066)}{0.134}\Delta\left(\frac{S}{Y}\right)_{t-1} - \underset{(0.083)}{0.344}\left(\frac{I}{Y}\right)_{t-1}$$

$$+\underset{(0.068)}{0.297}\left(\frac{S}{Y}\right)_{t-1} + \underset{(0.008)}{0.031}D1954_t - \underset{(0.008)}{0.024}D1964_t + \underset{(0.008)}{0.023}D1972_t + \underset{(0.007)}{0.018}D1983_t$$

$$-\underset{(0.008)}{0.037}D1989_t + \varepsilon_t \quad (6)$$

$R^2 = 0.823$, $F_{(10,26)} = 12.110[0.000]$, T = 37

$F_{(2,24)}^{AR(1-2)} = 1.405[0.265]$, $F_{(1,35)}^{ARCH(1)} = 0.267[0.609]$, $\chi_{(2)}^{Norm} = 1.540[0.463]$,

$F_{(10,21)}^{Hetero} = 0.652[0.755]$, $F_{(2,24)}^{RESET23} = 2.946[0.072]$

The second parsimonious model also passes the standard specification tests. The dummy for 1954 accounts for the massive crop failure of 1954 and the sudden and large increase in budget balance; for 1964 justifies the economic stagnation together with the Cyprian crisis; for 1972 explains the political turmoil and the aftermath of the 1971 Turkish military memorandum; for 1983 represents the start of the operation of the financial liberalization and trade openness policies as well as the first election after the 1980 military coup; and for 1989 represents the full capital market liberalisation (see Boratav, 2016 for the Turkish economic history).

The long-run elasticities of investment ratio with respect to saving ratio in the first period is $(-\theta_2/\theta_1 = -(0.297/-0.344)) = 0.86$. An increase of 1% in the saving ratio increases the investment ratio by 0.86%—a large impact. However, this result is consistent with the Feldstein and Horioka (1980) hypothesis that domestic investment and savings follow each other closely under imperfect international capital mobility, which characterizes the first period.

The implied long-run vector of (1, –0.86)′ allows us to impose a homogeneity restriction $\theta_1 = -\theta_2$, i.e., the long-run relationship vector between investment and saving ratios is $(1, -1)'$. The restricted ECM for the first period is given below:

$$\Delta\left(\frac{I}{Y}\right)_t = \underset{(0.002)}{0.004} - \underset{(0.094)}{0.352}\Delta\left(\frac{I}{Y}\right)_{t-2} + \underset{(0.047)}{0.197}\Delta\left(\frac{S}{Y}\right)_t + \underset{(0.066)}{0.145}\Delta\left(\frac{S}{Y}\right)_{t-1} - \underset{(0.069)}{0.289}\left(\frac{I}{Y} - \frac{S}{Y}\right)_{t-1}$$

$$+\underset{(0.008)}{0.034}D1954_t - \underset{(0.008)}{0.023}D1964_t + \underset{(0.008)}{0.023}D1972_t + \underset{(0.008)}{0.018}D1983_t - \underset{(0.008)}{0.040}D1989_t + \varepsilon_t \quad (7)$$

$R^2 = 0.814$, $F_{(9,27)} = 13.150[0.000]$, T = 37

$F_{(2,25)}^{AR(1-2)} = 0.629[0.542]$, $F_{(1,35)}^{ARCH(1)} = 1.703[0.200]$, $\chi_{(2)}^{Norm} = 2.249[0.325]$,

$F_{(8,23)}^{Hetero} = 0.804[0.606]$, $F_{(2,25)}^{RESET23} = 1.767[0.192]$

Again all retained coefficients are estimated with a high degree of precision with the homogeneity restriction. Figure 4 shows the actual and the fitted values in the left-top panel as well as the corresponding cross; the estimated regression residuals and autocorrelation function up to the seventh order are reported in the left- and right-bottom panels, respectively. They are all satisfactory. The model does not suffer from instability (Figure 5). The coefficient of the long-run relationship in Equation 7 indicates that 29% of disequilibria of the previous year is corrected in the next year.

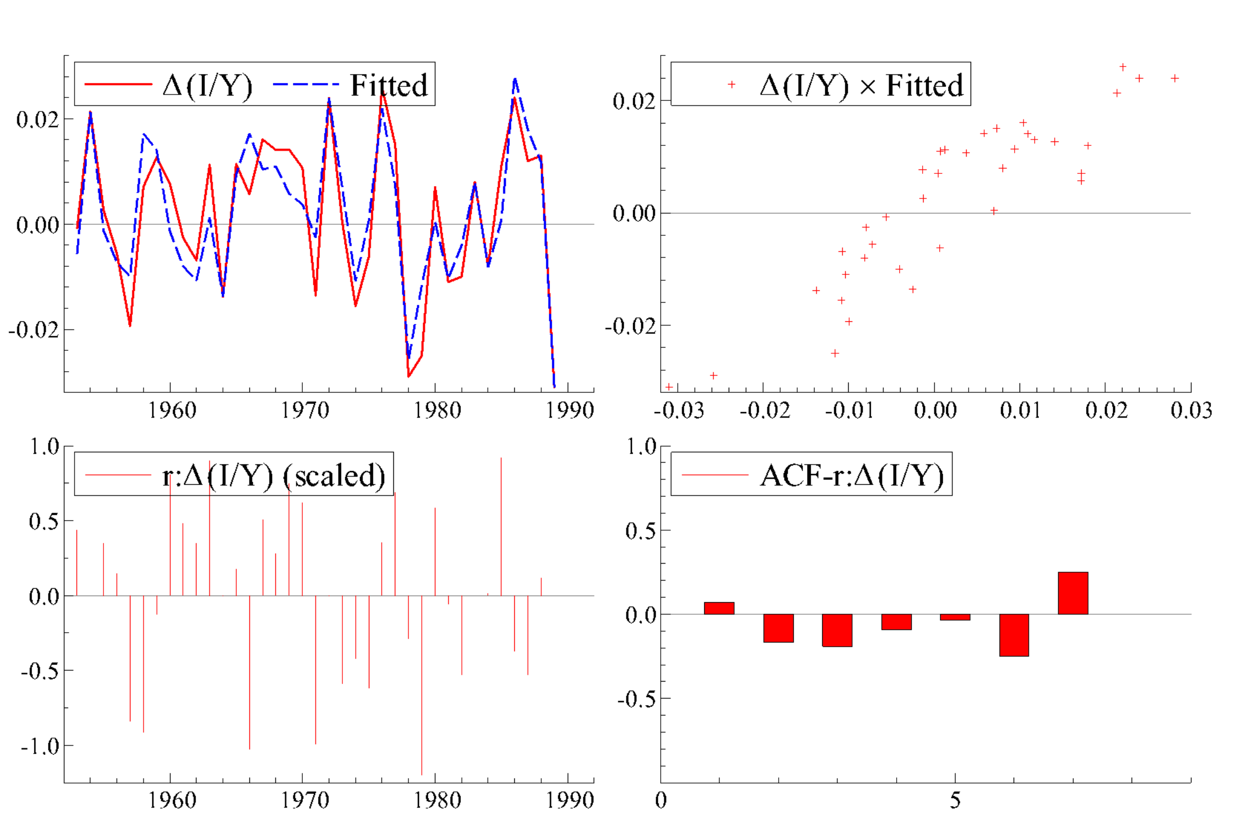

Figure 4. Actual and fitted values; cross-plot of actual and fitted values; regression residuals (r:Δ(I/Y)); autocorrelation function of regression residuals (ACF-r:Δ(I/Y)) – (1950-1989)

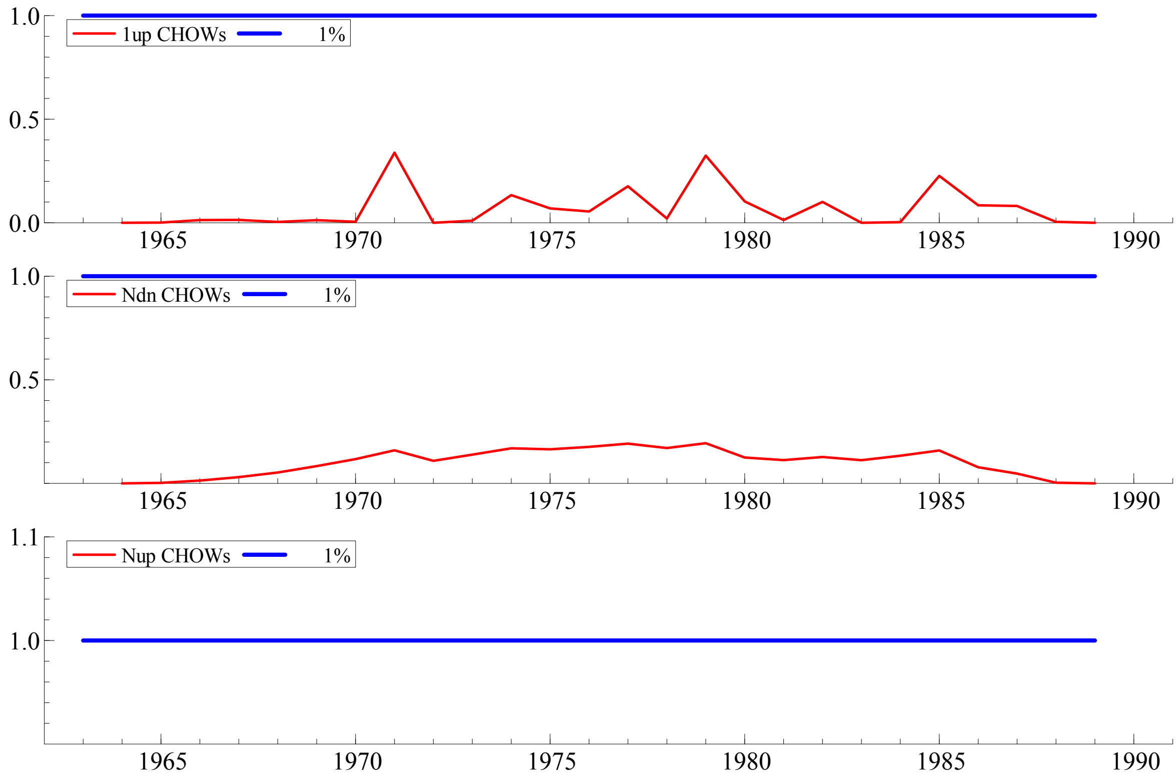

Figure 5. Recursive stability one-step, breakpoint and forecast Chow test statistics scaled by their respective 1% critical values – (1950-1989)

For the second period (1990–2017), as explained previously, *p* = *3* is selected and the null hypothesis of no long-run relationship between investment and saving ratios is rejected at the 5% significance level. We start with the ECM of *p* = *3* for the second period, again delete the insignificant augmentation lags, and reach the following parsimonious model:

$$\Delta\left(\frac{I}{Y}\right)_t = \underset{(0.039)}{0.125} - \underset{(0.131)}{0.231}\Delta\left(\frac{I}{Y}\right)_{t-2} + \underset{(0.214)}{1.036}\Delta\left(\frac{S}{Y}\right)_t + \underset{(0.170)}{0.246}\Delta\left(\frac{S}{Y}\right)_{t-2} - \underset{(0.072)}{0.174}\left(\frac{I}{Y}\right)_{t-1}$$

$$-\underset{(0.181)}{0.330}\left(\frac{S}{Y}\right)_{t-1} + \underset{(0.012)}{0.026}D1996_t - \underset{(0.012)}{0.036}D1998_t - \underset{(0.013)}{0.057}D2001_t + \varepsilon_t \quad (8)$$

$R^2 = 0.817$, $F_{(8,19)} = 10.590[0.000]$, T = 28

$F_{(2,17)}^{AR(1-2)} = 1.291[0.301]$, $F_{(1,26)}^{ARCH(1)} = 0.674[0.419]$, $\chi_{(2)}^{Norm} = 5.376[0.068]$,

$F_{(10,14)}^{Hetero} = 0.271[0.978]$, $F_{(2,17)}^{RESET23} = 0.041[0.960]$

The second parsimonious model also passes the standard specification tests. The dummies for the years, 1996, 1998, and 2001 are added to take outliers into account. The dummy for 1996 accounts for the impacts of the European Union–Turkey Customs Union agreement; the dummy for the year 1998 takes into account the data revisions in that year; and the dummy for 2001 explains the 2001 Turkish banking and currency crisis.

The long-run elasticities of investment ratio with respect to saving ratio in the second period is $(-\theta_2/\theta_1 = -(-0.330/-0.174)) = -1.89$. An increase of 1% in the saving ratio decreases the investment ratio by almost 2%. The existence of the negative relationship between investment and saving ratios is consistent with the theoretical arguments of Westphal (1983) that a higher world interest rate leads to an increase in the domestic interest rate, thus encouraging domestic savings but discouraging domestic investment. Similarly, Tobin (1983) argues that higher domestic savings do not necessarily lead to higher domestic investment if foreign returns are greater than the marginal return of domestic investments, because of the differences in taxation between countries. In addition, the large current-period short-run impact of the saving ratio may reflect short- and medium-term frictions in international capital markets (Hoffmann, 2004).

The long-run relationship between investment and saving ratios in Equation 8 can be written as the following ECT:

$$ECT_{t-1} = (\frac{I}{Y} + 1.89 * \frac{S}{Y})_{t-1}$$

The error-correction model that replaces the long-run relationship for the ECT for the second period is presented below:

$$\Delta\left(\frac{I}{Y}\right)_t = \underset{(0.030)}{0.125} - \underset{(1.81)}{0.231}\Delta\left(\frac{I}{Y}\right)_{t-2} + \underset{(0.182)}{1.036}\Delta\left(\frac{S}{Y}\right)_t + \underset{(0.165)}{0.246}\Delta\left(\frac{S}{Y}\right)_{t-2} - \underset{(0.044)}{0.174}ECT_{t-1}$$

$$+\underset{(0.012)}{0.026}D1996_t - \underset{(0.012)}{0.036}D1998_t - \underset{(0.013)}{0.057}D1989_t + \varepsilon_t$$

(9)

$R^2 = 0.817$, $F_{(7,20)} = 12.740[0.000]$, T = 28

$F_{(2,18)}^{AR(1-2)} = 1.367[0.280]$, $F_{(1,26)}^{ARCH(1)} = 0.675[0.419]$, $\chi_{(2)}^{Norm} = 5.376[0.068]$,

$F_{(8,16)}^{Hetero} = 0.250[0.974]$, $F_{(2,18)}^{RESET23} = 0.040[0.961]$

All retained coefficients are estimated with a high degree of precision with the inclusion of the ECT. Figure 6 shows the actual and the fitted values, the corresponding cross, and the estimated regression residuals and their autocorrelation function up to the seventh order, respectively. They are all satisfactory. The model does not show any signs of instability (Figure 7). The value of the ECT indicates that 17% of the disequilibria of the previous year comes back to the long-run equilibrium in the next year.

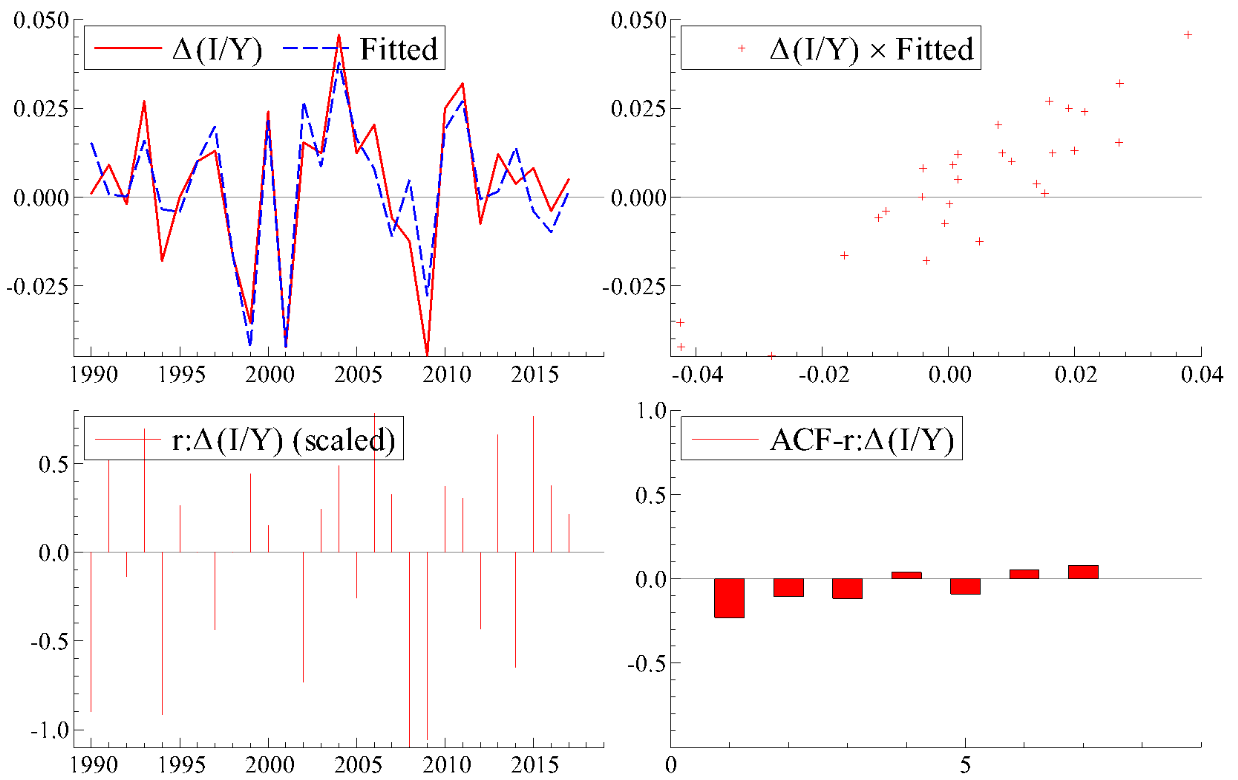

Figure 6. Actual and fitted values; cross-plot of actual and fitted values; regression residuals (r:Δ(I/Y)); autocorrelation function of regression residuals (ACF-r:Δ(I/Y)) – (1990-2017)

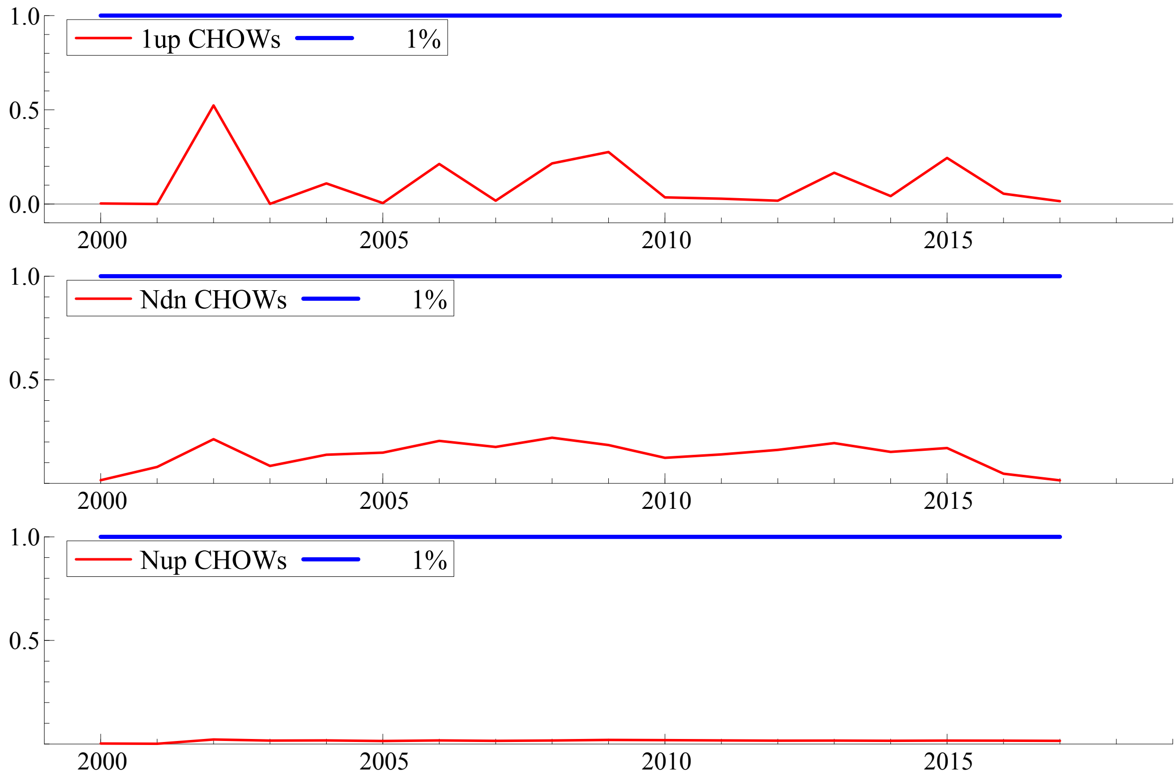

Figure 7. Recursive stability one-step, breakpoint and forecast Chow test statistics scaled by their respective 1% critical values – (1990-2017)

5. Conclusions

Feldstein and Horioka (1980) predicted that in a closed economy the domestic savings would follow domestic investments very closely. However, these scholars' empirical results presented a puzzle, because of a high saving investment correlation during the period of more open and integrated markets in the OECD countries. In this paper, the FH hypothesis is revisited and tested for Turkey over the 1950–2017 period and for two sub-periods (1950–1989 and 1990–2017). The first period is characterized by restricted capital mobility and the second period represents a period of perfect capital mobility.

Several novel contributions are made to the literature. First, the longest time period with two sub-periods for Turkey are studied. Secondly, we properly take into account the time series properties of the data by using the bounds-testing procedure that can be used in situations when there is no consensus in the literature on the order of integration of the variables of interest. Third, the presence of structural breaks is addressed when testing for the presence of a long-run relationship between investment and saving ratios.

Amongst the key findings, it is found that saving and investment are cointegrated for Turkey over the whole period and the sub-periods. However, the investment and savings are positively correlated during the period of restricted capital mobility (1950–1989) and negatively correlated during the period of perfect capital mobility (1990–2017). These results are in conformity with the FH hypothesis that in a closed economy domestic investments are financed with domestic savings. The negative correlation in the second period under perfect international capital mobility can be explained by higher world interest rates, which lead to an increase in the domestic interest rates and therefore domestic savings, but not necessarily to an increase in domestic investments, especially if foreign returns are greater than the returns on domestic investments due to differences in taxation between countries.

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Appendix A: The previous studies on Feldstein-Horioka Puzzle for Turkey

Study	Time Period	Data	Method	Results
Kar & Kara (2001)	1980 - 1998	The ratio of domestic investment to GDP and the ratio of domestic saving to GDP	The Engle-Granger two step cointegration approach	A high saving-investment correlation with a saving-retention coefficient of 0.89.
Bolatoğlu (2005)	1970 - 2003	The ratio of domestic investment to GDP and the ratio of domestic saving to GDP	Pesaran *et al.* (2001) bounds testing of cointegration	There is a long-run relationship between investment and saving rates, and the saving-retention coefficient is 0.52.
Yavuz (2005)	1962 - 2003	The ratio of investment to GDP and the ratio of domestic saving to GDP	The error correction model of Jansen (1996) and Jansen and Shultze (1996)	A long-run relationship between investments and savings with a saving-retention coefficient of 0.76.
Yentürk, Ulengin & Çimenoğlu (2009)	1989:1 – 2003:2	The ratio of private investment to GNP; and the ratio of private saving to GNP.	Johansen's maximum likelihood procedure	There is a cointegration between private investments and private savings.
Kaya (2010)	1984:1 - 2007:3	The ratio of total investment to GNP; the ratio of total saving to GNP; the ratio of private investment to GNP; and the ratio of private saving to GNP.	Pesaran *et al.* (2001) bounds testing of cointegration	There is a long-run relationship between total saving and investment with a saving-retention coefficient of 0.69, and the absence of correlation between private saving and investment.
İyidoğan & Balıkçıoğlu (2010)	1968 - 2008	The ratio of gross domestic capital formation to GDP and the ratio of gross domestic saving to GDP	Pesaran *et al.* (2001) bounds testing of cointegration	The absence of the long-run relationship between domestic saving and investment with a saving-retention coefficient of 0.39.
Altıntaş & Taban (2011)	1974 - 2007	The ratio of investment to GDP and the ratio of domestic saving to GDP	Pesaran *et al.* (2001) bounds testing of cointegration	A long-run relationship between investments and savings with one-fifth of the investments were

				financed through foreign savings.
Esen, Yıldırım & Kostakoğlu (2012)	1975 - 2009	The ratio of investment to GDP and the ratio of domestic saving to GDP	Pesaran et al. (2001) bounds testing of cointegration	A cointegration between domestic savings and investments with a saving-retention coefficient of 0.38.
Mangır & Ertuğrul (2012)	1998:1 – 2010:4	The ratio of gross investment to GDP and the ratio of domestic saving to GDP	Pesaran et al. (2001) bounds testing of cointegration; and the Kalman filter technique of time-varying parameter approach	A cointegration between domestic savings and investments with a saving-retention coefficient of 0.74 according to the Bounds testing procedure. However, the relationship between savings and investments weakens during the 2001:1-2001:4 and 2008:1-2008:4 period according to the Kalman filter technique.
Arısoy (2013)	1962 - 2010	The ratio of investment to GDP and the ratio of domestic saving to GDP	The error correction model of Jansen (1996) and Jansen and Shultze (1996)	A long-run relationship between investment and saving with a saving-retention coefficient of 0.26.
Güriş (2013)	1968 - 2012	Domestic investments to GDP ratio and national savings to GDP ratio	The Li & Lee (2010) Autoregressive Distributed Lag test for threshold cointegration	A cointegration between domestic savings and investments.
Altunöz (2014)	1980 - 2013	The ratio of investment to GDP and the ratio of domestic saving to GDP	Pesaran et al. (2001) bounds testing of cointegration	There is long-run relationship between domestic savings and investments with a saving-retention coefficient of 0.44.
Dursun & Abasız (2014)	1968 - 2008	Domestic investments to GDP ratio and national savings to GDP ratio	Hansen-Seo (2002) test of nonlinear structure; the single-structural break cointegration test of Gregory-Hansen (1996);	There is no nonlinear relationship between domestic investments and national savings, but the relationship is linear. The saving-retention coefficient is 0.86 with the single structural break cointegration test; and

			and the two structural break cointegration test of Hatemi_J (2008).	0.426 according to two-structural break test.
Akadiri, Ahmed, Usman & Seraj (2016)	1960 - 2014	Gross domestic saving and gross capital formation as a percentage of GDP	Co-integrating Likelihood Ratio Test	There is a long-run relationship between savings and investments with a saving-retention coefficient of 0.77.
Erdem, Köseoğlu & Yücel (2016)	1960 - 2014	Gross domestic saving and gross capital formation as a percentage of GDP	The Multiple-break cointegration test of Maki (2012) and Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) estimation procedures	A strong cointegration relationship between domestic saving and investment. The saving-retention coefficient is equal to 0.377 and 0.406 in the DOLS and FMOLS, respectively.
Demir & Cergibozan (2017)	1962 - 2015	Domestic investments to GDP ratio and domestic savings to GDP ratio	Johansen (1988) cointegration test; Pesaran et al. (2001) bounds testing of cointegration; and the Markov Regime Switching Model.	A strong relationship between domestic savings and domestic investment with a saving-retention coefficient of 0.89 for the 1962-1990 period according to Johansen cointegration test. However, for the 1990Q1-2015Q3 period the Bounds testing procedure delivers a saving-retention coefficient of 0.53. The Markov Regime Switching Model finds a structural break in 2001 for the 1990Q1-2015Q3 period with a much lower saving-retention coefficient of 0.16 after 2001.

Halıcıoğlu & Eren (2017)	1987 - 2004	Domestic investments to GDP ratio and national savings to GDP ratio	Pesaran *et al*. (2001) bounds testing of cointegration	A high correlation between domestic investments and savings and about less than 1/5 of domestic investments are financed from world financial markets.
Karabulut, Ekinci & Tüzün (2017)	1975 - 2014	Private sector savings to GDP; private sector investments to GDP; public sector saving to GDP; and public sector investments to GDP	The single-structural break cointegration test of Gregory-Hansen (1996)	There is no long-run relationship between private savings investments. However, there is a cointegration relationship between public sector savings and investments with a saving-retention coefficient of 0.27.
Çağlar & Yavuz (2018)	1960 - 2016	Domestic investments to GDP ratio and national savings to GDP ratio	The single-structural break cointegration test of Gregory-Hansen (1996); and Pesaran et al. (2001) Bounds testing of cointegration	There is a long-run relationship between savings and investments with a saving-retention coefficient of 0.68 according to DOLS test, and 0.83 according to the Bounds testing procedure.
Yıldırım & Koska (2018)	1960 - 2014	Gross domestic saving and gross capital formation as a percentage of GDP	The Kalman filter technique of time-varying parameter approach	The correlation between domestic savings and investments decreases over time.