

## Research Article

### Feldstein-Horioka (F-H) Approach Test in Developing Countries

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**Abstract:** The main objective of the present study is studying role of foreign aids and trade integrity on international mobility of capital in selected developing states. For do it, Feldstein-Horioka is applied for Iran economy. The obtained results are compatible with the common expectations related to the mobility of capital. Positivism of coefficients of variables of foreign aids indicates that accessing resources of financial funds in developing states has been increased with the increase of financial liberalization. Receiving foreign aids will result in increased supply of resources for granting loan, based on which, relation between domestic investments and saving will be diminished. Also, with receiving giant foreign loans by the mentioned countries, these countries will activate their investment and production cycles and their dependencies on domestic savings will be lessened.

**Keywords:** Capital mobility, Feldstein-Horioka, saving, trade

#### INTRODUCTION

The statement of the issue on “whether saving and investment have related to each other or not” has confused economists over the previous decades and the said issue has been known as F-H conundrum. In many of open-economy models, it has been assumed that capital is mobile to a great extent in international level. Horioka and Feldstein (1980) in their study in 16 OECD (Organization for Economic Co-operation and Development) countries within 1960-1974 showed that domestic investment and saving are correlated with each other extremely.

The so-called “Feldstein Horioka puzzle” (FH puzzle) has provoked a lively discussion in both theoretic and empirical literature. Two of the most investigated questions are: What does the saving-investment relation really measure and how should the saving-investment relation be measured? To answer the first question, various determinants of the SI relation have been suggested in the theoretical literature such as population growth (Obstfeld, 1986), the intertemporal budget constraint (Coakley *et al.*, 1996; Taylor, 2002), output fluctuations in non-traded goods (Tesar, 1993), or current account targeting (Artis and Bayoumi, 1992). Since the intertemporal budget constraint seems to be one of the most convincing reasons for a high SI relation, most recent empirical investigations for the SI relation are concentrating on a potential co-integration relation between saving and investment (Abbott and Vita, 2003; Gulley, 1992; Ho, 2002a, b; Leachman,

1991; Lemmen and Eijfinger, 1995; Haan and Siermann, 1994; Miller, 1988; Vita and Abbott, 2002). Thereby, error correction models are suggested as the suitable framework to measure the SI relation (Bajo-Rubio, 1998; Coiteux and Olivier, 2000; Jansen, 1996; Jansen and Schulze, 1996; Jansen, 1998; Pelgrin and Schich, 2004; Sinha and Sinha, 2004). However, no unique evidence for a co-integration relation between saving and investment is found. Compared to the abundant empirical investigations for the intertemporal budget constraint, empirical contributions linking all other determinants of the SI relation are rather scarce.

F-H Approach Test and studying role of foreign aids and trade integrity on international mobility of capital in selected developing states is the main objective of the present study. In economic literature, two main methods have been applied for studying existence or nonexistence of international mobility of capital. Rates of investment efficiency in various countries, existence or nonexistence of international mobility of capital are studied at the first method. This method is used when interest is applied in analysis of capital flows. With studying relation between domestic saving and investment rates, existence or nonexistence of international mobility of capital is studied at the second method.

For testing this theory, total data obtained from 13 developing countries from 1982 to 2012 is used. It should be noted that the said countries are divided into two economic blocs of East Asia and West Asia and pivotal variables, used in estimation, are variables of

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gross saving and investment. Existence of official foreign aids variable in saving-investment regression differentiates pattern of this study with other articles posed in relevant literature.

**RESEARCH METHOD**

**Modeling econometrics of capital mobility based on Feldstein-Horioka theory:** Frankel (1995) specified four main tools of capital mobility criterion:

- Application of definition of Feldstein-Horioka Theory
- Equality of real interest
- Non-covered interest rate parity
- Covered interest rate parity

The first criterion corresponds with long-term real capital flows while the last three criteria are dependent on financial capital flows. Since the present study concentrates on former criterion, Feldstein-Horioka Approach is applied:

$$[I/Y] = ai - Bri + ei$$

where,

- I* = Capital formation level
- Y* = National output
- r* = Domestic real interest rate
- α* = Factor of intercept

And “ε” presents other factors which specify investment. Since it has been assumed that national saving rate is a function of real interest rate, Feldstein-Horioka Approach estimated the following equation:

$$[I/K] = \mu i - \delta [S/Y] + vi$$

where,

- S* = Domestic gross saving
- μ* = Intercept
- v* = Error statement

Table 1: Descriptive statistics of research variables

|                 | I/Y      | S/Y       | A/Y      | TINTea   |
|-----------------|----------|-----------|----------|----------|
| Mean            | 6049.955 | 7639.643  | 25727.20 | 552663.8 |
| Median          | 4976.895 | 8273.000  | 18283.55 | 330141.6 |
| Maximum         | 12113.01 | 10099.30  | 81913.30 | 1901366  |
| Minimum         | 1537.960 | 3739.000  | 1776.300 | 64539.90 |
| S.D.            | 3881.220 | 1879.385  | 20007.84 | 527170.3 |
| Std. error mean | 518.6498 | 251.1434  | 2673.660 | 70446.09 |
| Skewness        | 0.157113 | -0.921190 | 0.826767 | 1.132881 |
| Kurtosis        | 1.378456 | 1.353673  | 1.653331 | 1.013758 |
| Jarque-bera     | 6.365666 | 8.894902  | 6.660157 | 11.97902 |

Static test through the application of dickey fuller unit root test

Table 2: Results of static test through the application of dickey fuller unit root for (I/Y) at level

| t-statistics                            |           | Prob.*    |        |
|---|-----------|-----------|--------|
| Augmented dickey-fuller test statistics |           | 2.307664  | 0.9997 |
| Test critical values:                   | 1% level  | -3.626784 |        |
|   | 5% level  | -2.945842 |        |
|   | 10% level | -2.611531 |        |

MacKinnon (1996) one-sided p-values

Null hypothesis: I/Y has a unit root; Exogenous: Constant; Lag length: 0 (automatic based on SIC, MAXLAG = 5)

If capital mobility is assumed, increased saving rate in “I” country will cause remarkable increase in investment rate of all countries.

The abovementioned econometric model is estimated through the application of EViews software package and with combinatory data methods.

**EMPIRICAL RESULTS**

**Studying variables descriptive statistics:** In below table, descriptive statistics related to Number (N), Mean, Standard Deviation, minimum and maximum of variables, Standard Error Mean, Skewness, Kurtosis, have been mentioned in the form of single by single variables separately:

These variables are mentioned at two research estimated models.

where,

- I* = Domestic gross investment
- Y* = Gross Domestic Product (GDP)
- S* = Gross domestic saving
- A* = Foreign aids and is the criterion of effective aids of development

Descriptive Statistics of Research Variables is shown in Table 1.

The carried out studies show that variables are unstable with regard to many of economic time series. Therefore, according to the ARDL (Auto Regressive Distributed Lag) Co-integration Theory in modern econometrics, it seems necessary that study should be carried out with regard to their stability and instabilities.

Dickey Fuller Unit Root Test is one of the most appropriate types of these tests.

Dickey Fuller Test under p = 1 null hypothesis is meant that time series are of unit root and is non-static and assuming that real data production process is without intercept.

Now, if calculated quantity of the favorite circumstantial evidence exceeded crisis quantity

Table 3: Static test through the application of dickey fuller unit root for me/Y in 1<sup>st</sup> order difference

| t-statistics                            |           | Prob.*    |
|---|-----------|-----------|
| Augmented dickey-fuller test statistics |           | -5.804393 |
| Test critical values:                   | 1% level  | -3.632900 |
|   | 5% level  | -2.948404 |
|   | 10% level | -2.612874 |

MacKinnon (1996) one-sided p-values  
 Null hypothesis: D (I/Y) has a unit root; Exogenous: Constant; Lag length: 0 (automatic based on SIC, MAXLAG = 5); Research findings

Table 4: Results of dickey-fuller test for research variables time series data

| Degree | Result   | Optimal stop No. | Highest Mackinnon crisis amount | Dickey fuller circumstantial evidence | Variable |
|--------|----------|------------------|---------------------------------|---------------------------------------|----------|
| I (1)  | Unstable | 5                | -2.610                          | 2.300                                 | I/Y      |
|        | Unstable | 5                | -2.610                          | -5.800                                | D (I/Y)  |
| I (1)  | Unstable | 2                | -3.610                          | -1.476                                | S/Y      |
|        | Unstable | 2                | -3.615                          | -6.060                                | D (S/Y)  |
| I (0)  | Unstable | 3                | -2.611                          | -4.550                                | A/Y      |
| I (0)  | Unstable | 1                | -3.621                          | -8.420                                | TINTea   |

Research findings

presented by Dickey-Fuller (MacKinnon), null hypothesis of the opposite hypothesis is rejected and we will have non-static time series.

As it is observed in Table 2, the amount of calculated circumstantial evidence (2.30) exceeds estimated crisis amounts (at all levels: 1, 5 and 10%, respectively).

Hence, it can be concluded that this variable is not static at surface. Hence, stability of this variable is assessed at first order difference.

The software produced results with regard to the aforementioned variable statics in first order difference will be as follows.

As it is observed (Table 3), the amount of calculated circumstantial evidence (-5.80) is less than the estimated crisis amount (at all levels). Therefore, it can be concluded that this variable is stable (at first order difference).

Summary of results of tests mentioned at level and first order difference of pattern time series for all variables of model has been mentioned at Table 4.

Symbol (D) in below table indicates first order difference of variables. The results of the abovementioned table, with regard to the stationarity of variables, indicate briefly as follows:

Variables of I/Y and S/Y are not stable at level but it is stable with regard to first order difference. Hence, it is a collective form of first order or I (1).

Variables of A/Y and TINTea are stable at level. Hence, it is a collective form of first order to I (0).

Thus, the first result of stationarity test specifies that research variables will turn stable either at level or first order difference. Accordingly, if degree of stationarity of variables is specified, fitting of the favorite pattern can be taken into consideration and models will not face problems.

Of course, since all variables are not static at level (some of variables turned stationarity at the first order differences), if estimation of model is resulted in augmented linear combination of null degree from variable of model according to the augmentation rule, regression will turn augmented as well.

For this reason, static test should be carried out on regression wastes (augmented test) after estimating model at any rate.

**Estimation of F-H model for developing states:**

According to econometrics methods, some criticisms have been put forward on Feldstein-Horioka Approach. Absfield (1995) states that that a large country can leave an impact on world real interest rate. Under such circumstances, real interest rate is not exogenous and is dependent on saving rate (Munshi and Wilson, 2010).

In this study, since none of developing countries is big enough to leave impact on world interest rate, the said statement is not found accurate. In other words, since the developing states cannot leave impact on world interest rate, the abovementioned statement is rejected. Moreover, Montiel (1994) state impact of foreign aid should be considered at Feldstein-Horioka Equation when relation of saving and investment is studied because, investment in many countries not only depends on domestic saving but also to the amount of foreign aid.

Hence, ignoring foreign aid reiterates investment function wrongly (Montiel, 1994).

Therefore, foreign aids are added to Feldstein-Horioka Saving-Investment Equation.

The results obtained from estimation of models according to the least squares and with the application of EVIEWS software is as follows:

Of course, two models have been estimated separately in a way that first model is related to East Asia bloc while the second model is related to West Asia bloc.

The information related to variables of model has been collected from IFS and UNCTD sources and also World Bank data CD.

**1<sup>st</sup> model: East Asia bloc countries:**

$$I/Y = 0.235 + 0.163 S/Y + 0.462 A/Y - 0.163 T (S/Y) + 1.17 TINTea$$

(2.43)    (3.07)    (5.34)    (-6.68)    (4.30)

$$R^2 = 0.94, D.W = 1.96, F\text{-statistic} = 112.07$$

Table 5: Complementary results of estimation of model through EVIEWS software

| Variable           | Coefficient | S.E.                     | t-statistics | Prob.    |
|--------------------|-------------|--------------------------|--------------|----------|
| S/Y                | 0.163510    | 0.225568                 | 3.079231     | 0.0059   |
| A/Y                | 0.462432    | 0.185520                 | 5.344434     | 0.0009   |
| T (S/Y)            | -0.163340   | 0.001338                 | -6.682231    | 0.0000   |
| TINT <sub>1a</sub> | 1.742554    | 9.301019                 | 4.300982     | 0.0006   |
| C                  | 0.235502    | 1201.279                 | 2.434450     | 0.0146   |
| R-squared          | 0.944502    | Mean dependent variable  |              | 5567.955 |
| Adjusted R-squared | 0.923239    | S. D. dependent variable |              | 4453.220 |
| S.E. of regression | 1409.351    | Akaike info criterion    |              | 21.37130 |
| Sum squared resid  | 89860841    | Schwarz criterion        |              | 14.58830 |
| Log likelihood     | -390.3964   | F-statistic              |              | 112.0788 |
| Durbin-watson stat | 1.960032    | Prob. (F-statistics)     |              | 0.000000 |

Dependent variable: I/Y; Method: Least squares; Date: 07/05/11; Time: 00:08; Sample: 1980-2009; Included observations: 30

Table 6: Complementary results of estimation of model through EVIEWS software

| Variable           | Coefficient | S.E.                  | t-statistic | Prob.    |
|--------------------|-------------|-----------------------|-------------|----------|
| S/Y                | 0.181009    | 0.213090              | 3.669942    | 0.0053   |
| A/Y                | 0.539013    | 0.177432              | 4.122438    | 0.0007   |
| T (S/Y)            | -0.150932   | 0.155464              | -5.300954   | 0.0000   |
| TINT <sub>1a</sub> | 0.142284    | 0.158832              | 5.589321    | 0.0000   |
| C                  | 0.182083    | 0.178032              | 4.044651    | 0.0006   |
| R-squared          | 0.911934    | Mean dependent var.   |             | 4040.132 |
| Adjusted R-squared | 0.890324    | S.D. dependent var.   |             | 4009.193 |
| S.E. of regression | 1339.076    | Akaike info criterion |             | 17.4092  |
| Sum squared resid  | 70094546    | Schwarz criterion     |             | 15.7764  |
| Log likelihood     | -179.4349   | F-statistic           |             | 88.3733  |
| Durbin-watson stat | 2.040930    | Prob. (F-statistic)   |             | 0.00000  |

Dependent variable: I/Y; Method: Least squares; Date: 07/05/11; Time: 01:13; Sample: 1980-2009; Included observations: 30

Other specifications of estimated model have been mentioned at the Table 5 and 6:

**2<sup>nd</sup> model: West Asia bloc countries:**

$$I/Y = 0.182 + 0.181 S/Y + 0.539 A/Y - 0.150 T (S/Y) + 0.142 TINT_{1a}$$

(4.04) (3.66) (4.12) (-5.30) (5.58)

$$R^2 = 0.91, D.W = 2.04, F\text{-statistics} = 88.37$$

**Interpretation of results and coefficients of estimated model:** Results obtained from estimation of final model and other calculations and tests indicate that:

- “t” circumstantial evidences indicate significance of all briefing variables in confidence level (95%)
- “R<sup>2</sup>” circumstantial evidence indicates that 94 and 91% of dependent variable changes can be explained with model briefing variables at first and second models, respectively
- Increased “F” circumstantial evidence of the two models indicates significance of whole regression
- Durbin-Watson circumstantial evidence at first model (1.96) and second model (2.04) rejects self-correlation hypothesis between components of model

Coefficients of briefing variables show that: With regard to the relation of saving with investment or capital mobility (S/Y), it can be said that S/Y Relation is positive with I/Y endogenous variable. Thanks to the economic theories, with the increased domestic saving rate, domestic investment will also be increased.

With regard to the variable coefficients T (S/Y), negativity of this coefficient indicates reduction of saving and investment rate relation after financial liberalization. The negative sign of this variable indicates that dependency of investment on domestic saving has been lessened after financial liberalization and investment-financial procurement has been increased through foreign financial resources at countries with newly-fledged markets.

In developing countries of East Asian bloc, trend and slope of non-dependency of investment to domestic saving (-0.163) has been intensified than West Asian countries (-0.150).

Eventually, negative and significance coefficient of this variable is meant that noticeable change has been carried out in capital mobility as a result of financial liberalization.

With regard to the A/Y variable coefficient or foreign aids, it is observed that estimated coefficients are both positive and meaningful. That is to say that increased receivables of financial funds through foreign aids will cause remarkable increase of capital flows and investment rate in these countries.

For example, in East Asian bloc, one unit increase of foreign financial aids has caused 46%-unit increase while in West Asian bloc; one unit increase in foreign financial aids has caused 53%-unit increase of investment rate.

So, positive role of foreign aids is proven in investment rate, economic growth and development.

As far as West Asian countries are concerned, productivity and optimal use of foreign financial aids for boosting investment has been exceeded East Asian states.

Table 7: Results obtained from dickey-fuller test for waste statement

| Model  | Variable                   | Dickey-fuller circumstantial evidence | Highest Mackinnon crisis circumstantial evidence | Stop turn | Result                       |
|--------|----------------------------|---------------------------------------|--|-----------|------------------------------|
| First  | Regression waste statement | -6.32                                 | -2.76  | 2         | Rejection of null hypothesis |
| Second | Regression waste statement | -2.02                                 | -2.02  | 0         | Rejection of null hypothesis |

Table 8: Durbin-Watson Circumstantial evidence and crisis quantity (CRDW)

| Model  | Durbin-watson amount resulted from regression | Crisis quantity at 5% level | Crisis quantity at 10% level | Result                       |
|--------|---|-----------------------------|------------------------------|------------------------------|
| First  | 1.96  | 0.386                       | 0.323                        | Rejection of null hypothesis |
| Second | 2.04  | 0.386                       | 0.323                        | Rejection of null hypothesis |

Table 9: Ramsey reset test results

| Ramsey reset test |                      |          |                      |          |
|-------------------|----------------------|----------|----------------------|----------|
| First model       | F-statistics         | 3.700920 | Prob. F (4.31)       | 0.010932 |
|                   | Log likelihood ratio | 8.994438 | Prob. chi square (4) | 0.000430 |
| Second model      | F-statistic          | 2.884540 | Prob. F (4.31)       | 0.010500 |
|                   | Log likelihood ratio | 8.223200 | Prob. chi square (4) | 0.001000 |

With regard to the effect of trade integration factor, it can be said that coefficient of this variable is significant in East and West Asian countries (TINT1a, TINTea) and enjoys positive sign.

This conclusion witnesses more capital mobility as a result of trade integration at the developing states.

Finally, combined effect of integration and foreign aids indicates optimization of capital mobility and adjustment of trade deviation at this region.

**Estimation of credit tests and model accuracy:** After estimation of model, accuracy of results and abovementioned estimated coefficients should be assured through econometrics and regression tests.

**Real test of regression:** This test is carried out in two ways: "Waste Statement Reliability Test" and "Co-Integration Regression Durbin-Watson test" (Gojerati, 2007).

**Waste statement reliability test:** Results of this test have been presented at Table 7.

Since Dickey-Fuller Circumstantial Evidence of Waste Statement is smaller at each of three models of crisis amount, hence, it can be concluded that waste management or pattern error is found stationarity at all levels and regression is real.

**Co-integration regression Durbin-Watson test:** Using co-integration Regression Durbin-Watson Test is the other method for studying existence or nonexistence of long-term relation between fitted variables. Generally, this test compares Durbin-Watson circumstantial evidence, obtained from initial regression, with the crisis amounts presented by Sargan and Bhargava. If quantity of circumstantial evidence of DW Test, related to co-integration, is found less than crisis amounts, null hypothesis (inappropriate waste statement) is accepted. The procedure of fulfilling this test is as follows:

Quantity of circumstantial evidence of Durbin-Watson Test, related to collective regression, is used for this test which "d" Durbin-Watson is equaled to null. The null hypothesis is written as follows:

$$H_0: d = 0$$

And its opposite hypothesis includes:

$$H_1: d > 0$$

Now, if quantity of circumstantial evidence of DW Test, related to co-integration regression, is found less than crisis amounts, null hypothesis is accepted. Namely, statements of unstable, unreliable are accidental (random). Comparison of this circumstantial evidence with Durbin-Watson amount for the two models of research is according to the Table 8.

With due observance to the obtained result, it can be said that co-integration (long-term relation) between extant variables at models is approved. Thus, it is specified that the abovementioned fulfilled regressions indicate equivalent long-term relation between model variables. In other words, estimated coefficients are not confirmed in the short term and they can be applied for the analysis of long-term relation.

**Ramsey reset test:** This test is regarded as one of the most reliable tests of recognizing structural stability of model and has been designed for studying regression pattern clarification error. Two circumstantial evidences (9F) and logarithm of accuracy and likelihood related to it is the efficiency of this test.

Reset results of this test Table 9 for research models indicate that, with due observance to the amounts of circumstantial evidences F and log Likelihood Ratio and probabilities of the mentioned circumstantial evidences and comparing amounts of the abovementioned circumstantial evidences with Table Chi Square, H0 hypothesis based on model structural stability can be rejected. Thus, each of three rest models is valid according to this test.

Also, results of errors distribution normality test (Wastes) and Jarque-Bare circumstantial evidence at this test indicates normality of distribution of errors and results of co-linear test and Variance Inflation Factor at this test (VIF) indicates rejection of co-linearity between variables.

WHITE Test was estimated for the identification of disparity of variance and results indicate nonexistence of disparity of variance at the model. In continuation, LM Test has been estimated for recognizing consecutive correlation of waste.

### CONCLUSION

The obtained results are compatible with the common expectations related to the mobility of capital. Positivism of coefficients of variables of foreign aids indicates that accessing resources of financial funds in developing states has been increased with the increase of financial liberalization.

Receiving foreign aids will result in increased supply of resources for granting loan, based on which, relation between domestic investments and saving will be diminished. Also, with receiving giant foreign loans by the mentioned countries, these countries will activate their investment and production cycles and their dependencies on domestic savings will be lessened.

Eventually, setting up monetary and financial institutes is recommended with the aim of collecting and mobilizing savings and guiding it for making infrastructural investments thanks to the high dependency of saving and investment variables to promote economic development and growth of country.

In other words, setting up financial and monetary institutes is suggested with the aim of collecting and mobilizing savings and steering it for making basic investment thanks to the high dependency of saving and investment variable to boost economic development and growth.

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