

# An Empirical Investigation of the Feldstein-Horioka puzzle in MENA Countries

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***Abstract:*** .

We use a cointegration analysis in panel data from six MENA countries, namely (Algeria, Egypt, Morocco, Saudi Arabia, Syria and Tunisia) to study the relationship between saving and domestic investment in these economies according to the Feldstein and Horioka theory. We compute panel-data cointegration tests following Levin-Lin, Im,Pesaran and Shin, and Pedroni. The results are different from those obtained in single-country data. Our empirical study shows evidence of a significant correlation, and thus no solution to the F-H puzzle, between saving and investment for this panel of six MENA countries despite the implications of international capital mobility.

## Introduction

According to Fedstein and Horioka (1980), the relationship between national savings and domestic investment can be used as a measure of international capital mobility.

The investors don't care which country they are investing in, if capitals is perfectly mobile between countries. The crucial factor that concerns investors is the rate of return. Thus, with perfect world capital mobility, domestic saving is not necessarily related to domestic investment.

In order to investigate the cointegration relationship between savings and investment, Miller (1988), Gulley (1992) and Hoffman (2001) explained capital mobility using the cointegration relationship between savings and investment. If there is cointegration between the two variables, the authors regard capital as highly immobile internationally. It is clear and intuitive idea, but limited only on individual countries.

In this paper, we propose to study the relationship between the investment and the saving, and thus to check the Fedstein and Horioka puzzle. By using a country panel, it enables us first to make richer analysis relating to the capital mobility, and to have econometric results more reliable than thus obtained in the individual countries. Similar studies were made on the OECD countries, among these studies we quote Corbin (2001) Coakley and al. (2001), Oh and al. (1993).

Since the appearance of Engle and Granger (1987) and Johanson (1988) papers, among others, bearing on the unit roots tests and the relationships of the economic and financial lot sizes cointegration. The time series analysis was revolutionized and becomes very practical to study the long term relationships between the economic variables, as indicated by Breitung and Meyer (1994). However, it is only recently that we become increasingly interested but the time series analysis between the countries which make it possible to have a richer data source in order to manage to find a better solution to the Dickey-Fuller test power dilemma in the unit root tests, traditionally used in the time series data.

Added to these advantages, the panels data analysis allows between the countries in short term dynamics, while keeping the same long term relationships between the countries since we refer to the same economic theory to establish the long term balance. Thus, by using at the same time the data individual and temporal variation, the cointegration analysis in the panel data has the advantage of identifying the effects which have an economic interest but not identified in the transverse section. Also to high light the characteristics specific to the countries and which are not observed in temporal variation.

In spite of the theoretical and methodological development known by the time series analysis in panel, it remains several questions to solve. First, we have always a choice problem between testing the unit root null hypothesis or specifying. Second, to correct the correlation in series, we must choose between a parametric method consistent in adding the delayed observations variations of the dependents variables in regression, and a non parametric method similar to that employed in the tests of Philips and Perron (1988).

In addition, and in the literature, we find different responses to question of statistic aggregation method for the groups, and the question of heterogeneity degree for the various individuals.

To test the non-stationary of the series, the following regression is considered:

$$(1) \quad \Delta Y_{it} = \alpha_i + \delta_i t + \beta_i Y_{it-1} + u_{it}, \text{ where } i = 1, \dots, N, \text{ and } t = 1, \dots, T.$$

The null hypothesis of unit root implies that  $\beta_i = 0$ , for any  $i$  Levin and Lin (1992) are based on restrictive hypothesis of the groups homogeneity,  $\beta_i = \beta$ , and test the null hypothesis  $\beta = 0$ , versus the alternative  $\beta < 0$ , (this test will be indicated by LL).

Even in a new version of there paper (Levin, Lin, and Chu (2002)) do not slacken (relaxed) the idea of the homogeneity. Im, Pesaran, and Shin (1997), indicated by IPS, criticize the LL test and present an alternative method to test the unit root in the panel data. The advantage of there test which is a statistic average ADF, consists inducing heterogeneity between the groups. Maddala and Wu (1999) develop a test based in the probability values of all root unit individual tests. Maddala and Wu show by simulation methods that their test is, generally, more powerful than the other root unit tests in the panel data.

However, it should be noted that in all these tests, in spite of their differences and also their performances remotely finished and the fact that the fallacious regressions problem does not arise for the pooled panel data (Kao, 1999), the researcher must always deal with decision, often difficult, concerning the delays (lag) number to be included, and also deterministic component specification, ie : the constant and the tendency term, which should be different according to the group, or similar to all the groups.

Moreover, these tests are likely to have a distortion problem in their size because of the correlation between the groups. On this subject, Maddala and Wu suggested to use the bootstrap tests, and other authors proposed similar ideas (see Hadri (2000) and Chang (2002)). In our study, we are based on the Levin-Lin (1992, 2002), Im, Pesaran and Shin (IPS) methods to test the root unit hypothesis in the panel data. Then, we apply the Pedroni, LL and IPS tests to study the cointégration in the panels.

## II. Result of the tests:

The data which are used cover the 1960-1998 periods, and relate to six countries of the Middle-East and North Africa (MENA), and for which the data are available: Algeria, Egypt, Morocco, Saudi Arabia, Syria and Tunisia. We are based on the following relationship:

$$\left(\frac{I}{PIB}\right)_t = \alpha + \beta\left(\frac{S}{PIB}\right)_t + \varepsilon_t \quad (1)$$

The variables indicate the investment, the saving and the GDP, respectively.

### a. *The relationship study for each country*

We start by studying the integration order of the investment rate series and saving rate. We use the unit root test (ADF) for individual data. By using various temporal shifts, the results are performed in table 1 for a test on level and a series test differentiated by the null hypothesis of non-stationary. These results indicate the non-stationary of all saving rate and investment rate series. The series are partly integrated in order 1.

Indeed, the Algeria and Morocco series are I(1).

**Table1: Unit root test for each variables series on level**

<i>countries</i>	<b>Unit root tests</b>				<b>Unit root test of first difference</b>	
	<i>Rate of investment</i>		<i>Rate of saving</i>		<i>Rate of investment</i>	<i>Rate of saving</i>
	<i>maxlag</i>		<i>maxlag</i>			
<i>Algeria</i>	1	-2,414733	1	-2 ,0741	-3.671690	-6.620042
<i>Egypt</i>	1	-2,157219	9	-0,78184	-4.412199	-1.92052***
<i>Morocco</i>	1	-2,022329	1	-3,06761	-4.818075	-5.944511
<i>Saudi Arabia</i>	4	-2,03266	2	-1,25529	-3.494929*	-2.890657**
<i>Syria</i>	12	-1 ,23532	2	-1,54704	-2.102119***	-5.099161
<i>Tunisia</i>	9	-1,50600	1	-2,57441	-1.712184***	-5.177548

\* Non-stationary with 1%critical value

\*\* Non-stationary with 1% and 5% critical value

\*\*\* Non-stationary

The second stage consists in testing the long term relationship between the domestic investment and national saving. In this respect, we apply the Johansen method to determine the cointegration relationships between the variables. It is clear that we can not make the cointegration test except for the series I(1).

The results performed in table 2 show the existence of a cointegration relationship for Algeria with the threshold of 1% for only one delay while there exists a long term relationship in the hole of the case for the two other delays 2 and 3. Added to that, it exists a cointegration relationship between the Morocco series.

**Table2: Cointegration test results for the individual data**

Lags	Countries	$\hat{\rho}^*$	$\rho t$	1% critical value	5% critical value	10% critical value
1	Algeria	-0.4635	-3.58451	-3.6171	-2.9422	-2.6092
2		-0.34258	-2.3805	-3.6228	-2.9446	-2.6105
3		-0.40431	-2.511	-3.6289	-2.9472	-2.6118
1	Morocco	-0.4635	-3.58451	-3.6171	-2.9422	-2.6092
2		-0.34258	-2.3805	-3.6228	-2.9446	-2.6105
3		-0.40431	-2.511	-3.6289	-2.9472	-2.6118

**b. The unit root tests in panel data**

We apply the Levin-Lin and IPS tests (which are also applied for heterogeneous panel) to test the variables non-stationary in panel.

We consider an order 1 autoregression model with fixed effect for the investment and saving variables reported to the GDP.

$$\left(\frac{I}{PIB}\right)_{it} = \rho \left(\frac{I}{PIB}\right)_{it-1} + \eta_{i1} + \varepsilon_{1,it} .$$

$$\left(\frac{S}{PIB}\right)_{it} = \rho \left(\frac{S}{PIB}\right)_{it-1} + \eta_{i2} + \varepsilon_{2,it} \text{ with } i=1,\dots,6, \text{ and } T = 1,\dots,39.$$

**Table3: LL unit root test**

	$\hat{\rho}^*$	$t_{\hat{\rho}}$	10%critical value	5%critical value
Rate of investment	0.821299	-1.46	-4.28	-4.88
Rate of saving	0.874009	-1.47	-4.28	-4,88

**Table 4: IPS unit root test**

<i>Variables</i>	$t_\rho$	<b>1% critical value</b>	<b>5% critical value</b>	<b>10% critical value</b>
<b>Rate of investment</b>	<b>-1.987</b>	<b>-2.30</b>	<b>-2.10</b>	<b>-2.02</b>
<b>Rate of saving</b>	<b>-2.015</b>	<b>-2.30</b>	<b>-2.10</b>	<b>-2.02</b>

The table 3 and 4 results show that the two test types considered confirm the non-stationary of savings and investment rates in panel.

**c. The panel data cointegration test**

One of the interest reasons in panel data cointegration tests is the superiority in their powers compared to the usual tests applied to individual tests. The used tests are based on the regression residues of the model variables. We use in our empirical study the LL, IPS and Pedroni tests.

The Levin and Lin procedure consists in considering a model for fixed proposes and imposing a homogeneous structure on the autoregression coefficients in the residues regression. We start with the regression on the aggregate level of the variables:

$$\left(\frac{I}{PIB}\right)_{it} = \alpha_i + \beta\left(\frac{S}{PIB}\right)_{it} + \varepsilon_{it} \quad i=1,\dots,N, \text{ and } T = 1,\dots,T. \quad (a)$$

Then, we test the null hypothesis of unit root in the residues in a similar way to cointegration tests based on the variables regression residues:

$$\Delta\hat{\varepsilon}_{it} = \rho\hat{\varepsilon}_{i,t-1} + \sum_{j=1}^p \theta_{ij}\Delta\hat{\varepsilon}_{i,t-j} + v_{it} \quad (b)$$

The non cointegration null hypothesis is given by  $H_0 : \rho = 0$ . Our results show that the LL test computed value is (-2.02), which is lower than the 10% critical value (-1.92). We reject the non-stationary hypothesis of the residues and can conclude there is a long term relationship between the investment rate and the saving rate in the MENA countries according to the LL test.

However, it should be noted this test is based on an IPS restrictive hypothesis resting on more flexible hypothesis by considering the regression coefficients heterogeneity and the  $\rho$

parameter. In this case, it is supposed that  $\beta$  and  $\rho$  are varied by country and we determine the ADF statistical tests calculated from the pooled panel data. Im, Pesaran and Shin determine the critical values of their tests obtained under the panel member's independence hypothesis.

**Table5:** *Cointegration IPS test in panel data*

<i>A number of delays</i>	$\bar{t}_\rho$	$\mu_{ADF}$
<b>K = 2</b>	<b>-2.340867</b>	<b>-1.476</b>
<b>K = 3</b>	<b>-2.095428</b>	<b>-1.470</b>

In this table, we present the computed values of IPS test, compared to the critical values ( $\mu_{ADF}$ ). The residues non-stationary hypothesis rejection is consolidated and thus we can affirm that there is a cointegration relationship in investment and saving for the MENA countries panel.

We have to announce that these results interpretation should be prudent. The dilemma is that we can have a “within” cointegration relationship as we can have a “between” cointegration relationship with the panel data.

The Pedroni statistical tests (1995, 1999) are normally distributed and allow the measurement of the two types of cointegration relationship.

We pass now to the Pedroni method application to analyze the relationship nature between investment and saving in our study. In this test type formulation, the null hypothesis in ADF regression of the residues is specified by  $H_0 : \rho_i = 0 \forall \mathbf{i}$ , against the alternative hypothesis  $H_1 : \rho_i < 0$  for at list one  $\mathbf{i}$ .

This root unit existence testing version makes it possible to consider the panel heterogeneity. The program RATS 5.11 results are reported in table 6.

**Table6:** *Pedroni cointegration tests in the panel data*

<b>Statistical test</b>	<b>Value of the test (<math>t_{\hat{\rho}}</math>)</b>
<b>Panel v-stat</b>	-1.76403
<b>Panel rho-stat</b>	-2.12123
<b>Panel pp-stat</b>	-2.45150
<b>Panel adf-stat</b>	-2.02392
<b>Group rho-stat</b>	-2.14800
<b>Group pp-stat</b>	-2.33899
<b>Group adf-stat</b>	-1.96416

Comparing the obtained values with the normal law value at 5% risk, we notice that the cointegration relationship exists on the intra and inter level in the MENA countries panel. Indeed, the first four tests are used to test the cointegration relationship intra groups and the other tests show there is an inter groups relationships.

These results are different from those obtained in the study of relationship between the investment and savings for each country taken individually.

Which are the long term relationship existence implication between the investment rate and saving rate on the capital mobility in MENA countries when the solvency constraint is taken explicitly into account. In another term, is the restriction  $\beta = (1, -1)'$  on the cointegration vector constraining?

**d. Root unit hypothesis testing for the currant accounts of the countries**

It was shown that we reject the noon cointegration hypothesis between the saving and the investment. In the following stage of our analysis we will see if the cointegrant vector is equal to  $(1, -1)'$ . If this hypothesis is true, the series  $(S/Y - I/Y = CA)$  defining the currant account would be  $I(0)$ . Now, we will test the unit root hypothesis for the  $CA_{it}$  variable by the IPS method.

$$CA_{it} = \alpha_i + (1 - \rho_i) CA_{i,t-1} + \sum_{j=1}^{mlag} \varepsilon_{ij} \Delta CA_{i,t-j} + \varepsilon_{it}$$

**Table7:** *Root unit test for payments balance currant account of the MENA countries*

	<b>statistical Test</b>	<b>1%Critical value</b>	<b>5%Critical value</b>	<b>10%Critical value</b>
<b>Currant account</b>	<b>-3.477</b>	<b>-2.30</b>	<b>-2.10</b>	<b>-2.02</b>

According to the value, we reject the non-stationary null hypothesis of the residues. We can consider that  $(1, -1)'$  is a cointegration vector between the saving and the investment, and thus, the currant account series is stationary for the MENA countries panel. It confirms the long term solvency presence implied by the intertemporal models, but which does not constitute capital mobility obviousness.

Feldestein and Horioka consider the countries in development process receive the intertemporal budgetary constraint and thus this cannot measure the capital mobility in these countries. In addition, Feldestein and Horioka (1980) are based on the correlation between the saving investment to evaluate the capital mobility degree. In their empirical study, they analyze regressions out of transverse sections and find that the capital mobility is at a bottom grade for the OECD countries. Indeed, it is a long term solvency rather than the capital mobility degree which was measured by Feldestein and Horioka in their study.

We share the Sinn (1994) and Coakley an al.(1997) ideas basing on finding a solvency constraint obviousness if the intertemporal ideal modal is taken, which involves a perfect capital mobility. It is concluded that the solvency constraint requires the currant account stationary since the country cannot make the Ponzi game with these debts.

### **III. Conclusion**

In our relationship study between investment and saving in the MENA countries, the cointégration analysis in the panel data did not let to solve the Feldestein and Horioka puzzle. The international financing system is characterized by a greater capital mobility, which is translated for the countries in development process, as their savings one not necessarily invested in their economies. This conclusion, announced in several studies, is explained by the opening is not favourable to the under developed countries at least concerning their debts. Until there, the statistical tool often use is based on the cointegration relationship between the domestic investment and national saving for each country. The absence of cointegration in this case is explained by the capital flights.

In this study we have considered a six countries group in the MENA area and have applied the cointegration relationship for all six countries. Our statistical results show a long term balanced relationship, therefore of cointegration between the investment and saving for the countries together.

In fact, the existence of this long term relationship between the saving and investment suggest that the saving in MENA area remains the principal financing means for the investment. This can mean mainly that the capital account and the financial investment. Thereafter, we can affirm that the international capital flows are not yet as a fundamental contributing to the investments financing, which implies that the saving plays a first order role.

All in all, it appears to us that is a significant result encouraging these countries to reinforce more the agreements to the investing opportunity in the MENA area in order to support a dynamics of total economic development all the area.

## REFERENCES

- 1- Breitung, J. and Mayer, W. (1994) "Testing for unit roots in panel data: Are wages on different bargaining levels cointegrated?" *Applied Economics*, 26, 353-361.
- 2- Chiang, M.H. and Kao, C. (2001) "Nonstationary panel time series using" NPT 1.2 – A User Guide, Center for Policy Research, Syracuse University.
- 3- Coakley, J. and Kulasi, F. (1997) "Cointegration of long span saving and investment", *Economics Letters*, 54, 1-6.
- 4- Coakley, J., Fuertes, A. M., and Spagnolo, F. (2001) "The Feldstein Horioka puzzle is not as bad as you think", Birkbeck College Discussion Paper 4-2000, Revised oct 2003.
- 5- Corbin, A. (2001) "Country specific effect in the Feldstein-Horioka paradox: A panel data analysis", *Economics Letters*, 72, 297-302.
- 6- Engle, R.F. and Granger, C.W.J. (1987) "Cointegration and error correction: representation, estimation, and testing", *Econometrica*, 55, 251-276.
- 7- Feldstein, M., Horioka, C., (1980) "Domestic saving and international capital flows". *Economic Journal* 90,1.
- 8- Gulley, O.D. (1992) "Are saving and investment cointegrated? Another look at the data", *Economics Letters*, 39, 55-58.
- 9- Hadri, K. (2000) "Testing for stationarity in heterogeneous panel data", *Economics Journal*, 1, 1-14.
- 10- Hoffman, M. (2001) "The Feldstein Horioka puzzle and a new measure of international capital mobility", *Journal of International Money and Finances*, Forthcoming.
- 11- Im, S.-K., Pesaran, M.H. and Shin, Y. (1997) "Testing for Unit Roots in the heterogeneous panels", DAE Working Paper N° 9526. University of Cambridge.
- 12- Johansen, S. (1988) "Statistical analysis of cointegration vectors", *Journal of Economic Dynamics and Control*, 12, 231-254.
- 13- Kao, C. (1999) "Spurious regression and residual-based tests for cointegration in panel data", *Syracuse university journal of econometrics*, 90, 1-44.
- 14- Levin, A. and Lin C,F. (1992) "Unit Root tests in panel data: asymptotic and finite sample properties", UCSD. Discussion Paper, 23-92.
- 15- Levin, A. and Lin C-F et Chu, C-S. (2002) "Unit Root tests in panel data: Asymptotic and finite sample properties. *Journal of Econometrics*, 108, 1-24.

- 16- Maddala, G.S. and Wu, S. (1999) "A Comparative Study of Unit Root Tests with Panel Data and a New Simple Test", *Oxford Bulletin of Economics and Statistics*, 61, 631-652.
- 17- Miller, S.M. (1988) "Are saving and investment cointegrated?" *Economic Letters*, 27, 31-4.
- 18- Oh, K. and al (1993) "Saving-investment cointegration in panel data", *Applied Economics Letters*, G, 477-480.
- 19- Pedroni, P. (1995) "Panel Cointegration, asymptotic and finite sample properties of pooled time series tests with an application to the PPP" , *Indiana University Working Paper in Economics*.
- 20- Pedroni, P. (1996) "Fully modified OLS for heterogenous cointegrated panels and the case of PPP", *Indiana University Working Paper in Economics*, 96-020.
- 21- Pedroni, P. (1997) "Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis New Results", *Indiana University Working Paper in Economics*, 95-013.
- 22- Pedroni, P.(1999) "Critical values for cointegration tests in heterogeneous panels with multiple regressions" forthcoming, *Oxford Bulletin of Economics and Statistics*, 61, 653-670.
- 23- Phillips, P.C.B and Perron, P. (1988) "Testing for a unit root in time series regressions" *Biometrika*, 75, 335-346.
- 24- Sinn, S. (1994) "Saving-investment correlations and capital mobility: On the evidence from annual data", *Economic Journal*, 102, 1162-1170.