

# The Global Side of the Investment-Savings Puzzle

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## Abstract

In this paper we re-examine the long standing and puzzling correlation between national savings and investment in industrial countries. We apply an econometric methodology that allows us to separate idiosyncratic correlation at the country level from correlation at the global level. In a major break with the existing literature, we find no evidence of a long run relationship in the idiosyncratic components of savings and investment. We also find that the global components in savings and investments comove, indicating that they react to shocks of a global nature.

**JEL Classification Code:** C31, C33, F32, F41.

**Key Words:** Savings; Investment; Feldstein-Horioka Puzzle; Panel Nonstationarity; Principal Components.

## 1. Introduction

Since it was first highlighted by Feldstein and Horioka (1980), the substantial correlation between national investment and savings in industrial countries, despite international capital flows, has become one of the most resilient puzzles in international economics. Feldstein and Horioka (FH) suggested that the long run immobility of international capital is at the root of the puzzle. Even though increasing globalisation was expected to eliminate the causes of such immobility, recent studies have shown that national savings and investment correlations are still at levels inconsistent with perfect capital mobility.<sup>1</sup>

According to alternative explanations, savings and investment could be correlated even if capital were perfectly mobile. For example, intertemporal general equilibrium open economy models (see Glick and Rogoff, 1995) argue that while in the short run a high correlation reflects domestic shocks and the comovement of international real business cycles (see Tesar 1991, Mendoza 1991, Backus, Kehoe and Kydland 1992, and Stockman and Tesar 1994), in the long-run savings-investment correlations are in line with a “solvency constraint.”<sup>2</sup> Along these lines, Obstfeld and Rogoff (2000) highlight the role of trade costs in explaining the puzzle.<sup>3</sup>

Additionally, the positive correlation between savings and investment could be explained by endogeneity, if both were jointly determined by a third common force. Obstfeld (1986), for example, argues that the savings-investment correlation may be due to the common influence of economic growth. Similar arguments extend to population growth, productivity shocks or fiscal policies that target a balanced current account (see for example Tobin, 1983). Attempts to uncover common shocks to

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<sup>1</sup> Obstfeld and Rogoff (2000) and Singh (2007) provide a review of recent papers in this field.

<sup>2</sup> This should imply a cointegrating relationship between savings and investment and, consequently, a stationary current account.

<sup>3</sup> Fazio, MacDonald and Mèlitz (2008) provide empirical evidence in support of this hypothesis.

savings and investment have usually centred on Feldstein-Horioka regressions augmented by domestic variables considered as jointly impacting savings and investment.<sup>4</sup> Taylor (1994) and Iwamoto and van Wincoop (2000) propose a different approach and estimate a factor-free FH coefficient by performing the FH regression on the unexplained residuals from conditional savings and investment regressions.

In this paper, we re-examine the long standing empirical puzzle of high national savings-investment correlation using recent advances in the econometric literature on panel factor models. In particular, we employ a methodology that allows us to separate comovements borne out at the idiosyncratic level from those at the global level. The movements in the idiosyncratic series can thus be considered as orthogonal to international factors that drive savings and investment across countries. Once the series have been “cleaned” of their international component, we can reassess the puzzle by considering movements in savings and investment that can be truly interpreted as determined by domestic factors only. In a second step, we assess whether the international factors behind national savings and investment are themselves jointly determined. In a major break with existing literature, we reject the existence of a long run relationship in the idiosyncratic components of savings and investment. However, we are able to identify a cointegrating relationship between their global factors. This result is consistent with capital mobility since long run movements in investment are associated with long run movements in savings at the global level, irrespective of what global shocks drive these two processes. The rest of this paper is set out as follows: section two reviews our econometric approach; section three discusses the data and results; section four concludes.

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<sup>4</sup> Feldstein and Horioka (1980) are aware of the problem of endogeneity and attempt to mitigate it by including population growth in their original regressions. They find that conditioning on population growth does not change their results.

## 2. Econometric Methodology

In a traditional approach to examining the relationship between investment and savings, investment as a share of GDP,  $I_{it}$ , is a function of national savings as a proportion of GDP,  $S_{it}$ . In a panel framework:

$$I_{it} = c_i + \beta_i S_{it} + e_{it}, \quad (1)$$

$c_i$  is a set of country fixed effects and  $\beta_i$  are slope coefficients. If there is no long run relationship between investment and savings and they are both unit root processes,  $I_{it} = I_{it-1} + e_{1it}$  and  $S_{it} = S_{it-1} + e_{2it}$ , we cannot reject the null hypothesis  $H_0: \rho_i=1$  where  $e_{it} = \rho_i e_{it-1} + u_{it}$ , (random error terms are denoted by  $e_{it}$ ,  $e_{1it}$ ,  $e_{2it}$  and  $u_{it}$ ). Moreover, if there is a relationship between savings and investment, then this is consistent with low capital mobility for these countries since domestic investment is, in a sense, constrained by domestic savings.

However, as identified by O'Connell (1998) and Maddala and Wu (1999), tests of the null hypothesis that  $\rho_i=1$ , where  $e_{it} = \rho_i e_{it-1} + u_{it}$ , have a size distortion in the presence of residual cross-sectional correlation (i.e.  $\text{corr}(u_{jt}, u_{kt}) \neq 0, \forall j \neq k$ ) due to common shocks. In other words a statistical test will tend to indicate a relationship when none exists. We would anticipate global shocks affect macroeconomic aggregates in industrial countries and Figure 1 clearly indicates that there are common components in industrial countries' savings and investment.

In this paper we seek to account for common shocks by using a principal components approach based on Bai and Ng (2004) and test for cointegration using Pedroni (2004) and Johansen (1988), as suggested by Gengenbach, Palm and Urbain (2006). Importantly, both investment and savings may be driven by common elements in the context of global shocks to capital flows, an issue at the heart of the FH puzzle.

**[Figure 1 about here]**

Following the econometric methodology of Bai and Ng (2004) and Gengenbach, Palm and Urbain. (2006), we can decompose saving and investment as follows:

$$I_{it} = c_{1i} + \lambda'_{1i} F_{1t} + \varepsilon_{it} \quad (2)$$

$$S_{it} = c_{2i} + \lambda'_{2i} F_{2t} + \eta_{it} \quad (3)$$

Consequently, suppressing fixed effects  $c_{1i}$  and  $c_{2i}$ , we can rewrite equation (1) as a linear combination of factors,  $F_{1t}$  and  $F_{2t}$ , and idiosyncratic components,  $\varepsilon_{it}$  and  $\eta_{it}$ , where  $\lambda_{1i}$  and  $\lambda_{2i}$  are factor loadings:

$$I_{it} - \beta_i S_{it} = \lambda_{1i} \left( F_{1t} - \frac{\beta_i \lambda_{2i}}{\lambda_{1i}} F_{2t} \right) + \varepsilon_{it} - \beta_i \eta_{it} \quad (4)$$

A stationary linear combination  $I_{it}, S_{it} \sim CI(1,1)$  with a cointegrating vector  $(1, -\beta_i)$  requires two conditions:  $F_{1t} - (\beta_i \lambda_{2i} / \lambda_{1i}) F_{2t} \sim I(0)$  and  $\varepsilon_{it} - \beta_i \eta_{it} \sim I(0)$ . Intuitively, the common factors must form a long run relationship, as must the de-factored data.

We apply a two step procedure to account for cross-sectional correlation that in our view drives the savings-investment puzzle and exploit the properties of the factors to draw further inference on the relationship between investment and savings. In a first step, the panel time series of national savings and investment are examined for nonstationarity using the Bai and Ng (2004) PANIC approach. Here, consistent estimates of the global factors are obtained based on the principal components derived after first differencing the data. The factors are then used to identify whether the potential nonstationarity is in the panel time series' idiosyncratic and/or global component.<sup>5</sup> This approach yields the benefit of allowing us to identify the common,  $F_{1t}$  and  $F_{2t}$ , and idiosyncratic components,  $\varepsilon_{it}$  and  $\eta_{it}$ , from equation (4). Once the

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<sup>5</sup> Jang and Shin (2005) suggest that Bai and Ng (2004) has preferable estimation properties to other second generation panel unit root tests.

panel time series have been de-factored, they are orthogonal to global shocks and can be considered as entirely determined by domestic influences.

In our view, the relationship between idiosyncratic savings and investment and the relationship between the global factors in savings and investment provide valuable information for the resolution of the Feldstein Horioka puzzle. In a second stage we therefore follow Gengenbach et al. (2006) and test for cointegration: (a) between the idiosyncratic components,  $\varepsilon_{it} - \beta_i \eta_{it} \sim I(0)$ , using Pedroni (2004) tests for panel cointegration and (b) between the factors,  $F_{1t} - (\beta_i \lambda_{2i} / \lambda_{1i}) F_{2t} \sim I(0)$ , using the Johansen (1988) Trace Test. Testing for cointegration between the idiosyncratic components we can test the puzzle as specified by Feldstein and Horioka. Factor cointegration would imply that industrial countries have a global factor in investment, which is associated with a global factor in savings.<sup>6</sup>

### 3. Empirical Evidence

#### 3.1 Data

Data for gross domestic savings and gross fixed capital formation as a percentage of GDP for twenty-one industrial countries have been collected from the World Development Indicators of the World Bank. In particular, we have selected a sample of annual data from 1971 up to 2004, allowing us a panel of  $N = 21$ ,  $T = 34$  dimensions. The list of countries includes Australia, Austria, Belgium, Canada,

**[Table 1 about here]**

Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, United Kingdom

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<sup>6</sup> Cointegration is only a necessary condition if the idiosyncratic and common components are nonstationary.

and the United States. In Figure 1, we have plotted the panel time series of our investment and savings data. The data present evidence of both stochastic trends and a high degree of cross sectional correlation. Investment and savings appear to have declined towards the middle of the 1980s, and since then have tended to be constant or to slightly increase. The high degree of comovement in the series at the cross sectional level motivates further our factor analysis approach.

### *3.2 Empirical Estimation*

As can be seen from Table 1 we identify nonstationarity in our data using the Bai and Ng (2004) PANIC methodology. We are unable to reject the null hypothesis of unit root for both the idiosyncratic component and factor component of our panel time series. As the idiosyncratic components of savings and investment are nonstationary, we can apply the panel cointegration test proposed by Pedroni (2004).<sup>7</sup> In Table 2 these panel test statistics suggest that we cannot reject the null hypotheses of no cointegration between the idiosyncratic component of savings and investment at the 5% significance level. Consistently with perfect capital mobility, there is no significant co-movement between the country-specific components of savings and investment.

**[Table 2 about here]**

However, when we examine the relationship between the savings and investment principal components in Table 2, the Johansen (1988) Trace Test statistics indicates that we can reject the null hypothesis of no cointegration ( $r=0$ ) between the

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<sup>7</sup> See Pedroni (2004) for a discussion of the different panel cointegration test statistics. In this context, applying Pedroni (2004) tests to the raw data would be inadequate since we would only be able to take account of cross sectional correlation utilizing time dummies. These presume that common shocks have a common impact upon cross sections, unlike the Bai and Ng (2004) methodology that allows common shocks to have a differential impacts upon cross sections (e.g.  $\lambda_{1j} \neq \lambda_{1k}, \forall j \neq k$  in equation (2)).

factors at the 5% significance level and accept the null of one cointegrating vector ( $r=1$ ). This confirms that there is an association between investment and savings but this relationship is globally, rather than idiosyncratically, determined. These results are not due to differences in the power of our statistical tests. Indeed, panel tests (which do not reject the null hypothesis) are typically considered to have more degrees of freedom and hence to be more powerful, while standard time series tests are considered to have lower power. In contrast, here we are able to reject the null of no cointegration for the Trace Test but are unable to reject the null of no cointegration for Pedroni's panel cointegration tests, which if anything reinforces our results.

Our conclusion of no relationship between idiosyncratic savings and investment is consistent with the assumption of capital mobility, but appears to go against intertemporal solvency, given the argument that external solvency should require cointegration between savings and investment. However, Bohn (2007) recently demonstrates that stationarity and cointegration tests are misplaced as a test of sustainability. Bohn (2007) shows, for the case of fiscal sustainability, that in an infinite sample any order of integration of debt is consistent with the Transversality Condition and this implies that Intertemporal Budget Constraint is always satisfied. An extension of Bohn's arguments to external solvency is also discussed in his paper and failure of savings and investment to cointegrate is therefore not necessarily a violation of external solvency. Our results leave the ground open for interpretation with respect to the cointegrating relationship in the global components of savings and investment.

#### **4. Conclusions**



Despite the increasing integration of international capital markets, the savings-investment puzzle identified by Feldstein and Horioka (1980) remains an elusive issue in the international economics literature. In this paper, we have taken a novel approach to the empirical assessment of the puzzle arguing that its main source lies in the international components behind national savings and investment. In particular, we have first isolated idiosyncratic and global components in savings and investment and then tested these for cointegration. This approach reveals relationships between savings and investment which are entirely consistent with capital market integration: savings and investment are not domestically correlated, as it is suggested by economic theory under the assumption of long run perfect capital mobility. Indeed, it is the common global component in savings and investment which potentially explains the previous puzzling empirical evidence. However, our results call for further investigation on the global savings-investment relationship.

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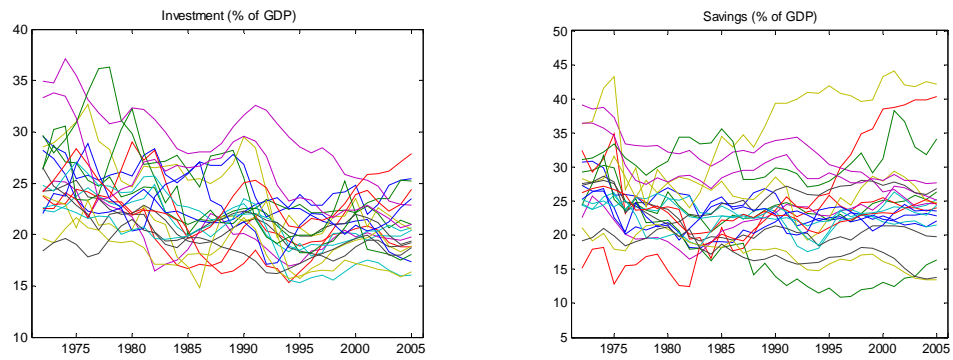
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**Figure 1: Investment and Savings in Industrial Countries**



**Table 1: PANIC Panel Unit Root Tests**

| <i>National Investment</i> |                  | <i>National Saving</i>  |                  |
|----------------------------|------------------|-------------------------|------------------|
| Idiosyncratic Component    | Factor Component | Idiosyncratic Component | Factor Component |
| -1.499                     | -2.042           | 0.183                   | -1.319           |

*Notes:* We use annual data on savings and investment for twenty one countries from 1971 to 2004 ( $N=21$ ,  $T=34$ ). Results are based on equation (2). We identify one factor structure using an information criterion from Bai and Ng (2002). For the factor unit root test, we reject the null hypothesis of a unit root for large negative (less than -2.89) and for the idiosyncratic component we reject the null hypothesis of a unit root for large positive values of the test statistic.

**Table 2: Idiosyncratic and Factor Cointegration**

| <i>Pedroni (2004) Idiosyncratic Cointegration</i> |               |               |
|---|---------------|---------------|
|   | Panel         | Group         |
| $\rho$ -Statistic                                 | -1.345        | -0.179        |
| PP-Statistic                                      | -1.507        | -0.882        |
| ADF-Statistic                                     | -1.573        | -1.552        |
| <i>Johansen (1988) Factor Cointegration</i>       |               |               |
| Ho: r =   | Trace Test    | p-value       |
| 0   | <b>20.26*</b> | <b>0.018*</b> |
| 1   | 4.41          | 0.285         |

*Notes:* We use annual data on savings and investment for twenty one countries from 1972 to 2004 ( $N=21$ ,  $T=33$ ). Bold and star (\*) denotes rejection of the null of no cointegration at the 5% significance level. The panel tests statistics are distributed as a standard normal and have a 5% critical value of -1.96. The number of cointegrating vectors in the Johansen (1988) Trace Test is denoted by r and AIC lag length is 4.