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Revisiting the Feldstein-Horioka Puzzle: An Institutional Sector View (*)

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Abstract

Working on a unbalanced sample of OECD countries spanning the period 1970-2003, this paper contributes to the empirical literature on the Feldstein-Horioka puzzle by making three main innovations: First, it goes beyond the traditional national-level investment-saving equations to estimate, for the first time, regressions at the institutional sector level (households, corporations, and government). Second, it explores the implications of giving separate consideration to current account deficits and surpluses. Lastly, it uses advanced panel data techniques to deal with endogeneity and to distinguish long- and short-run effects. After discarding the influence of common factors, the conclusions are that: (i) The national Feldstein-Horioka coefficient is in the vicinity of 0.5, but sectoral coefficients are much lower and even insignificantly different from zero; (ii) Such positive and significant national coefficient would not reflect frictions in international credit markets but just a fiscal current account targeting policy; (iii) Nevertheless, when the sample is split into deficit and surplus years, a higher and significant correlation emerges for the former at the national, household, and corporate level, implying that credit imperfections still play a role for the private but not for the public sector. Equally noteworthy, household correlation is still positive and significant, yet lower, for surplus years; and (iv) Against the background of a unitary long-run coefficient to satisfy the intertemporal budget constraint, the long-run relationship is 0.75 for national data, 0.6 for the corporate sector, and marginally or non-significant at the household and government level.

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Introduction

The seminal paper of Martin Feldstein and Charles Horioka (1980) unleashed a heated debate that still mesmerizes scholars and remains at the center of the macroeconomic research agenda. In its simplest form, the Feldstein-Horioka (henceforth, FH) test consists of running a regression of the national investment rate on the national saving rate, either for cross-section, time series or panel data. Let β be the estimated coefficient. Allegedly, $\beta=1$ indicates financial autarky (the usual macroeconomic identity of a closed economy) and $\beta=0$ signals full capital mobility. FH´s finding that the investment and saving rates are highly correlated has proven to be a robust stylized fact for both industrial and developing countries over time. Our principal goal is to bring attention into the institutional sector breakdown of saving and investment under the conviction that it should enrich our understanding of this famous and polemic issue in international finance. We will be working with a unbalanced sample of OECD countries spanning the period 1970-2003. The choice of this particular dataset was motivated by the unavailability of investment and saving time series by institutional sector in most countries and because the odds that Feldstein-Horioka should fail are the highest in view of their level of economic, institutional and financial development. The widespread statistical acceptance of a sizable yet decreasing correlation becomes, as a result, both intriguing and challenging.

Indeed, the correspondence between high capital mobility and the value of β is disputable on intuitive grounds. For example, as discussed in Sachsida and Caetano (2000), a country running each year a constant current account deficit to GDP of 10% with investment and saving to GDP moving upward and downward at the same pace would yield a β coefficient equal to one, even though most people would characterize this country as facing high capital mobility. One can come up with other odd cases: The same country with its constant 10% external deficit, but with investment and saving stuck over time at 30% and 20% of GDP, would have now a zero β coefficient. Moreover, some empirical studies take the proportion of the change in investment financed with external saving as a measure of capital mobility (see Sachs (1981) and Glick and Rogoff (1995)), but such measure is difficult to reconcile with the Feldstein-Horioka coefficient. Put in other words, FH is a nice measure of how well the current account varies to fill the gaps between investment and saving, when the latter variables

are subjected to large and asymmetric shocks, but it is not the ultimate test of capital mobility.

Nevertheless, the intellectual and policy value of the Feldstein-Horioka test should not be undermined by this controversy. At the end of the day, it remains a powerful test of international financial constraints. In perfect international capital markets (free from intermediation costs, asymmetric information, and other frictions), a country should be indifferent to finance its investment with domestic or foreign saving. On the contrary, evidence that domestic investment tracks domestic saving implies that international capital mobility is not perfect. Rephrasing, a β coefficient positive and significantly different from zero supports the lack of full capital mobility. This approach is borrowed from the test designed for individual companies by Fazzari, Hubbard and Petersen (1988), who run investment equations on internal funds, claiming that a positive and significant coefficient, after controlling for investment opportunities, is an indication of financial constraints.[1,2]

The critique that has shed the darkest shadows over the validity of this test as a measure of capital mobility is that they might be an artifact of economic and statistical shortcomings. For the sake of exposition, we can classify the arguments into the following categories:

a. *Endogeneity*. Whenever the saving rate is positively correlated with the error term, the β coefficient will be upward biased, regardless of the true degree of financial constraints. One frequently raised case in the literature is that saving and investment might react in a similar fashion to third economic forces other than financial constraints (see for example Payne (2005), and Loayza et al. (2000) and Serven (2002) on the empirics of private saving and investment, respectively). As an illustration, a higher GDP growth rate is likely to simultaneously increase current saving and investment.

[1] Hubbard (1998) extensively reviews the literature and cites several sources of disagreement over the validity of the test, some of them along the same lines as those against the Feldstein-Horioka test. But as in the latter case, this test has been resilient to criticism and is still widely used in finance.

[2] For the most part, studies on national and corporate financial constraints do not take into account wealth stocks. This might give rise to misleading conclusions, as a non significant correlation of investment and saving may be due to fluid access to credit and/or the use of accumulated financial assets. However, we will not pursue this issue throughout the paper.

Likewise, as governments may set narrow targets of current account imbalances, measures may be in place to maintain a tight correlation of saving and investment by, say, modifying interest rates or the fiscal balance.

b. *Intertemporal budget constraint*. In order to meet this budget constraint, saving and investment should be equal to each other in the long run, but not necessarily in the short run.

This paper makes an original contribution to the FH literature by exploring the institutional sector dimension in OECD countries. The mounting work on this puzzle has so far neglected the implications of the household, corporate and government components of the national saving and investment rates.[3] Why this research angle is of utmost relevance comes from the very fact that countries are just abstract entities. Actually, those who engaged (or not) in financial relations with the rest of the world and with each other are the households, the corporations, and the government. To draw any sound policy advice on financial openness, a clear understanding of sectoral behavior is called for. For instance, from an economic growth perspective, a financially-constrained corporate sector is more pervasive than the household or the government sector going through such situation; on the contrary, financial stability would likely be less at risk with a financially-constrained government sector, especially in developing economies. Equally important, the comparison between the national β coefficient and the sectoral β coefficients provides a nice test of international vis-à-vis intranational financial constraints, allowing to have a better grasp about how financial markets work within countries by taking a closer look at intersectoral flows.

Beyond the data-related value added, our work advances in other fronts, especially in tackling the caveats cited above. First, we test the robustness of our results by using different panel data techniques and by accounting for common and fiscal factors affecting saving and investment. Second, we split the sample into current account deficits and surpluses to unveil possible asymmetries. Finally, we employ novel

[3] The only (at least to our knowledge) two papers that test FH paying attention to sectoral decomposition reach conflicting results. Argimon and Roldan (1994) investigate the casual relationship between the saving-investment gaps of the government and the private sector in European countries over 1960-1988 without finding any connection. However, Iwamoto and van Wincoop (2000) report negative correlations of more than 80% for OECD countries in 1975-1990.

dynamic panel data estimators to distinguish long- and short-run investment-saving comovements.

The structure of the paper is as follows: In Section 1, we describe our database and highlight some stylized facts. In Section 2, we run our baseline national and sectoral Feldstein-Horioka regressions, with and without controlling for potential common factors. A fiscal behavior approach is put forward in Section 3 to interpret our findings, which are further dissected by separating deficit and surplus years in Section 4. The distinction between long-run and short-run sensitivity of investment to saving is discussed in Section 5. Some conclusions close.

Section 1: Stylized Observations

Before going into the econometrics, several patterns in the series (in all cases, gross rates to GDP) involved will be underlined, some of which will help rationalize later findings. Tables 1 to 8 report country averages and standard deviations of the saving, investment and current account rates to GDP at the national and sectoral levels. The following facts stand out:

(i) In spite of being a rather homogeneous set of countries, pronounced differences in investment and saving rates strike the eye, both for national and sectoral figures. For example, the national saving rate ranges from 15.7% in the UK to 32.6% in Korea and 31.2% in Switzerland. Incidentally, the dispersion is higher in saving than in investment rates;

(ii) As highlighted in Bebczuk and Schmidt-Hebbel (2006), the corporate sector generates on average more saving than any other sector in the economy, although in 6 out of the 16 countries it is the household saving the one leading the saving statistics. On the investment side, the corporate sector contributes with the bulk of the national investment (57.9%), although the household and government sectors are responsible for significant fractions (28.7% and 13.4%). This defies the usual textbook claim that households save and businesses invest, with the financial system acting as the intermediary of funds;

(iii) The average national current account is just 0.6%, but, again, huge differences across countries are found. The range goes from –4.4% in Australia to 7.6% in Switzerland. These figures indicate that foreign saving finances a marginal portion of domestic saving (2.4% on average and a maximum of 17.5% in Australia);

(iv) Current accounts behave quite differently across sectors. Households have an average surplus of 3.4% of GDP (with only 3 deficit countries), while corporations and governments display deficits of 1.6% and 1.2% respectively;

(v) Elemental macroeconomic theory leads us to expect that the current account is more volatile than both consumption and investment, based on the role of shock absorber of the current account under capital mobility. Strikingly, we find in the sample that the current account is roughly as volatile as the saving rate in national and sectoral data, and that the saving rate is on average at least as volatile as the investment rate, even though this is not a regularity on a country-by-country basis (see Fanelli (2005a, 2005b) for a thorough discussion on volatility in macroeconomic variables).[4]

[4] It could be argued that it is private saving and investment what should be looked at, as stated by the corporate veil literature. Nevertheless, results do not change qualitatively.

Table 1
Gross National Saving and Investment to GDP:
Country Averages

Country	S	I	S-I
Belgium	23.7	20.1	3.7
UK	15.7	17.9	-2.1
Switzerland	31.2	23.6	7.6
Italy	21.2	21.4	-0.2
Japan	31.0	29.0	2.0
Norway	28.3	24.6	3.7
US	17.2	19.2	-2.0
Netherlands	25.0	21.4	3.6
Spain	21.0	22.5	-1.5
Finland	24.1	23.8	0.2
Germany	20.7	21.0	-0.3
Australia	20.8	25.1	-4.4
Denmark	19.3	19.8	-0.5
France	20.2	20.5	-0.3
Canada	20.5	21.7	-1.1
Korea	32.6	32.1	0.5
Average	*23.3*	*22.7*	*0.6*
St. Dev.	*5.1*	*3.7*	*2.9*

Table 2
Gross Household Saving and Investment to GDP:
Country Averages

Country	S	I	S-I
Belgium	11.7	5.7	6.0
UK	5.3	4.3	1.0
Switzerland	11.2	5.9	5.3
Italy	19.3	7.9	11.5
Japan	13.2	6.8	6.3
Norway	5.3	5.9	-0.7
US	8.5	7.2	1.4
Netherlands	10.7	6.0	4.7
Spain	7.9	5.5	2.4
Finland	5.9	7.1	-1.1
Germany	11.1	7.5	3.6
Australia	11.6	9.8	1.8
Denmark	3.8	4.4	-0.6
France	9.8	6.7	3.1
Canada	10.4	6.4	4.0
Korea	13.1	6.8	6.3
Average	*9.9*	*6.5*	*3.4*
St. Dev.	*3.8*	*1.3*	*3.3*

Table 3
Gross Corporate Saving and Investment to GDP:
Country Averages

Country	S	I	S-I
Belgium	14.1	12.4	1.8
UK	10.3	11.7	-1.4
Switzerland	17.4	14.6	2.8
Italy	6.1	10.7	-4.5
Japan	14.3	16.8	-2.5
Norway	14.2	15.3	-1.1
US	9.2	9.6	-0.4
Netherlands	10.7	12.1	-1.4
Spain	12.2	13.5	-1.3
Finland	12.1	13.4	-1.3
Germany	9.3	11.4	-2.1
Australia	8.3	12.3	-4.0
Denmark	14.6	13.5	1.1
France	9.1	10.7	-1.6
Canada	10.3	12.2	-2.0
Korea	11.9	20.5	-8.6
Average	*11.5*	*13.2*	*-1.6*
St. Dev.	*2.9*	*2.7*	*2.6*

Table 4
Gross Government Saving and Investment to GDP:
Country Averages

Country	S	I	S-I
Belgium	-2.1	2.0	-4.1
UK	0.1	1.9	-1.8
Switzerland	2.6	3.1	-0.5
Italy	-4.2	2.9	-7.1
Japan	3.5	5.4	-1.9
Norway	8.8	3.4	5.4
US	-0.5	2.5	-3.0
Netherlands	3.6	3.2	0.4
Spain	0.9	3.5	-2.6
Finland	6.1	3.4	2.6
Germany	0.3	2.1	-1.8
Australia	0.9	3.1	-2.2
Denmark	0.9	1.9	-1.0
France	1.2	3.1	-1.9
Canada	-0.1	3.0	-3.1
Korea	7.6	4.8	2.8
Average	*1.9*	*3.1*	*-1.2*
St. Dev.	*3.4*	*1.0*	*3.0*

Coverage: Belgium, 1985-2003; UK, 1987-2003; Switzerland, 1990-2002; Italy, 1980-2003; Japan, 1980-2002; Norway, 1978-2003; US, 1970-2003; Netherlands, 1980-2003; Spain, 1981-2003; Finland, 1975-2003; Germany, 1991-2003; Australia, 1970-2003; Denmark, 1981-2003; France, 1978-2003; Canada, 1970-2003; Korea, 1975-2003.
Source: OECD (www.sourceoecd.org)

Table 5
Gross National Saving and Investment to GDP:
Standard Deviation of Country Rates

Country	S	I	S-I
Belgium	2.4	1.4	1.8
UK	1.2	1.8	1.3
Switzerland	1.9	2.6	2.7
Italy	1.7	2.5	1.6
Japan	2.4	2.4	1.0
Norway	3.4	3.9	5.7
US	2.1	1.5	1.3
Netherlands	1.7	1.3	1.5
Spain	1.6	2.0	1.7
Finland	3.5	5.0	4.3
Germany	1.0	2.1	1.3
Australia	3.0	2.5	1.7
Denmark	2.5	1.8	2.5
France	1.8	1.9	1.7
Canada	2.7	2.3	2.0
Korea	5.1	4.0	4.7
Average	*2.4*	*2.4*	*2.3*

Table 6
Gross Household Saving and Investment to GDP:
Standard Deviation of Country Rates

Country	S	I	S-I
Belgium	1.6	0.7	1.7
UK	1.7	0.6	2.2
Switzerland	0.7	0.7	1.1
Italy	5.7	1.2	4.8
Japan	2.2	1.1	1.4
Norway	1.5	1.9	2.7
US	2.3	0.9	2.2
Netherlands	1.5	0.7	2.1
Spain	0.9	0.7	1.3
Finland	1.6	2.0	2.4
Germany	0.5	0.6	0.9
Australia	3.8	1.4	3.3
Denmark	2.0	0.8	2.4
France	1.4	1.3	1.5
Canada	3.3	0.8	3.1
Korea	4.0	2.0	3.2
Average	*2.2*	*1.1*	*2.3*

Table 7
Gross Corporate Saving and Investment to GDP:
Standard Deviation of Country Rates

Country	S	I	S-I
Belgium	1.5	1.1	1.2
UK	1.7	1.4	2.4
Switzerland	1.5	1.7	2.0
Italy	1.7	1.0	2.4
Japan	2.0	1.7	3.2
Norway	1.0	2.3	2.0
US	0.8	1.0	1.1
Netherlands	1.5	1.2	1.5
Spain	1.3	1.3	1.9
Finland	3.3	2.9	4.9
Germany	0.8	1.3	1.4
Australia	1.8	1.4	2.4
Denmark	2.0	1.5	2.4
France	1.7	1.0	2.0
Canada	2.0	1.5	2.5
Korea	1.9	2.7	3.3
Average	*1.7*	*1.6*	*2.3*

Table 8
Gross Government Saving and Investment to GDP:
Standard Deviation of Country Rates

Country	S	I	S-I
Belgium	3.4	0.4	3.6
UK	2.6	0.5	2.9
Switzerland	1.4	0.4	1.5
Italy	3.4	0.5	3.9
Japan	2.7	0.6	2.8
Norway	3.8	0.5	4.1
US	2.0	0.2	1.9
Netherlands	3.6	0.3	3.7
Spain	1.9	0.6	2.0
Finland	4.2	0.4	4.1
Germany	0.9	0.5	0.7
Australia	2.1	0.7	2.2
Denmark	2.8	0.3	3.0
France	1.8	0.3	1.8
Canada	3.3	0.5	3.3
Korea	2.2	0.7	1.8
Average	*2.6*	*0.5*	*2.7*

Coverage: Belgium, 1985-2003; UK, 1987-2003; Switzerland, 1990-2002; Italy, 1980-2003; Japan, 1980-2002; Norway, 1978-2003; US, 1970-2003; Netherlands, 1980-2003; Spain, 1981-2003; Finland, 1975-2003; Germany, 1991-2003; Australia, 1970-2003; Denmark, 1981-2003; France, 1978-2003; Canada, 1970-2003; Korea, 1975-2003.
Source: OECD (www.sourceoecd.org)

Section 2: Baseline Econometric Results

We start by running the FH equation for national investment and saving, as well as for household, corporate and government figures, using three panel data techniques: pooled OLS, Random Effects, and Fixed Effects. The results presented in Table 9 point towards a national coefficient ranging between 0.43 and 0.60, much in line with previous studies.[5] Our main interest, though, are the sectoral coefficients, and they are consistently lower than the national one. The household FH coefficient is always significant and varies from 0.15 to 0.17. The corporate and government coefficients are not significantly positive, except in the pooled OLS specification. However, a Chow test indicates that the latter method is inconsistent vis-à-vis Fixed Effects, implying that the intercept homogeneity constraint is rejected, so we will disregard the pooled model and focus instead in the other estimators from now on.[6] Consequently, we are able to claim that the household coefficient is about one third of the national one, and that the positive investment-saving correlation disappears at the corporate and government levels.

Table 9
Baseline National and Sectoral Feldstein-Horioka Regressions

	National	Household	Corporate	Government
Pooled OLS	0.60 (16.45)***	0.173 (9.29)***	0.385 (10.4)***	0.089 (7.84)***
Random Effects	0.496 (11.88)***	0.15 (6.87)***	-0.028 (-0.6)	-0.008 (-0.92)
Fixed Effects	0.479 (10.62)***	0.146 (6.4)***	-0.059 (-1.21)	-0.011 (-1.33)

As mentioned in the Introduction, FH exercises are sometimes said to be driven by the existence of common factors explaining saving and investment and not by imperfect capital mobility. To put our results to the test, we will follow two procedures. The first one builds on Iwamoto and van Wincoop (2000), who perform a conditional FH test for OECD countries and Japanese regions to eliminate usual suspects that may jointly shape saving and investment decisions, and then use the unexplained residuals of the corresponding regressions to estimate a common-factor-free FH coefficient. The

[5] For example, Boyreau and Wei (2004) obtain for the whole, balanced OECD sample an estimate of 0.71 in 1960-1977 and 0.46 for 1978-2001.
[6] Hausman tests were unconclusive regarding the choice between random and fixed effects across the different regressions. However, as the coefficients are quite similar to each other, this does not represent a serious dilemma.

estimated β become insignificantly different from zero in their time-series exercises as such controls are entered. While an ingenious procedure, it is disputable whether to attribute the weakening of the saving-investment relationship to a successful elimination of the endogeneity bias or to the mere introduction of multicollinearity. Financial constraints are not directly observable, and there is no bullet-proof method to make sure the β is not biased as a result of misspecification –financial constraints may be correlated with some of the common factors. For example, a temporary productivity shock tends to increase both saving and investment. As a result, we are tempted to control for, say, the GDP growth rate. However, the macroeconomic literature states that the excess sensitivity of saving and investment to current GDP growth may well be explained also by myopia or financial constraints. In the latter case, the unexplained residuals will not fully capture the financial constraint component that was intended to isolate in the first place, probably reducing the significance of the estimated coefficient β. Nonetheless, as far as the estimated coefficients do not change in response to the inclusion of new controls in both sides of the equation, the baseline results should look more reliable.

After demeaning annual data substracting annual cross-country averages –which is equivalent to introducing time dummy variables but preserves degrees of freedom- as a means of eliminating common international systemic factors, we controlled both investment and saving for GDP growth, the inflation rate and per capita GDP and used the resulting residuals to compute the FH coefficient, yielding the estimates shown in Table 10. Previous results in this Section stay the same to a great extent, with the exception of the government coefficient that becomes significant, but still below a value of 0.05.

Table 10
Conditional FH Tests

	National	Household	Corporate	Government
Random Effects	0.482 (13.27)***	0.126 (5.41)***	0.055 (1.13)	0.049 (4.8)***
Fixed Effects	0.462 (11.49)***	0.118 (4.77)***	0.01 (0.21)	0.046 (4.5)***

Yet another test of robustness is to employ internal instruments by applying the GMM system technique on both the unconditional and the conditional regressions as a way of dealing with the potential endogeneity of saving –see the Annex for a description of this method.[7] Again, no noteworthy change is observed, as revealed by Table 11:[8]

Table 11
GMM System FH Estimates

	National	Household	Corporate	Government
Unconditional FH coefficient	0.543 (4.02)***	0.136 (1.00)	0.21 (0.92)	-0.054 (-1.48)
Conditional FH coefficient	0.433 (3.25)***	0.163 (2.18)**	-0.241 (-2.08)**	-0.067 (-2.39)**

After discarding the presence of spurious correlations, we are prepared to concentrate ourselves on a new puzzle within the FH puzzle, as the marked contrast between the national and sectoral results begs some interpretation.

Section 3: Fiscal behavior and the Feldstein-Horioka Puzzle

Is it sensible to expect the national FH coefficient to be higher than sectoral coefficients? Since the interaction between the private and the public sector is key to approach this question, we will do some elementary algebra to shed light on this finding. FH states that $i = \beta s$, where i and s are the investment and saving rates, respectively, and β is the FH coefficient. As national investment can be expressed as $i = i_p + i_g$, that is, the sum of private and public investment, and that there exist sectoral FH relationships of the form $i_p = \beta_p s_p$ and $i_g = \beta_g s_g$, the nacional FH coefficient can be written as $\beta = \beta_p (s_p / s) + \beta_g (s_g / s)$, namely, a weighted average of sectoral coefficients, with the weights being the proportions in national saving. This gives an intuitive answer that clashes with the empirical results: a country cannot be more financially-constrained than their domestic institutional sectors.

[7] We used the second to the sixth lags as instruments in the GMM exercises conducted throughout the paper. Results were in general (but not always) robust to changes in the lag structure. Sargan and first- and second-order autocorrelation tests indicate that no specification problems were present.

[8] Actually, the irrelevance of common factors should not come as a total surprise. Recalling that past studies encountered that FH coefficients declined in a noticeable way over time, the common factor rationale should figure out what theory supports such time-varying influence of third variables.

We propose a fiscal-related explanation for coexistence of high national and low sectoral FH coefficients. Suppose that the government aims to target the national current account by running a surplus (deficit) every time the private sector runs a deficit (surplus), following the rule $s_g - i_g = a(s_p - i_p)$, where $a \leq 0$ –a=-1 implies that the target is a balanced current account. Redefining the FH equation as $s - i = (1-\beta)s$ and inserting the fiscal rule and the private sector FH equation $i_p = \beta_p s_p$, β equals $\beta = 1 - \left[(1+a)(1-\beta_p)s_p / s\right]$. Note for any given value of β_p, the lower a, the higher β. As an extreme example, if $a = -1$, then $\beta = 1$ even with $\beta_p = 0$, a case in which, whatever imbalance the private sector runs, the public sector fully offsets it so as to reach a nil current account and thus a perfect national investment-saving correlation.

In order to assess how well this story fits the data, we ran a regression of the public on the household and corporate current accounts. As apparent from Table 12, a negative and strong correlation exists in both cases, with a stronger reaction to household vis-à-vis corporate imbalances, lending support to the hypothesis that the national positive FH coefficient comes from fiscal current account targeting rather than from imperfect capital mobility.

It might be argued that the relationship has to be negative under no capital mobility, as the sum of the sectoral current accounts must be zero. But this is not the case in this sample. Moreover, if that were the case, the R-squared should be close to one, and is actually around 0.4. Additionally, when the private sector is broken down into corporations and households, the sign is not restricted to be negative in both cases even under no capital mobility. Another possible criticism is that the relationship may go the other way around, from public to private saving, by invoking partial or full Ricardian equivalence. After some simple regression analysis, we concluded that government saving is more sensitive to private investment than to saving, so Ricardian equivalence does not drive our results –alongside, public investment is much less responsive to private sector imbalances.[9] All this boils down into the high volatility of the public

[9] We ran the following regressions: (a) Government Saving = -4.3 –0.44 Private Saving + 0.79 Private Investment and (b) Government Investment = -0.79 –0.06 Private Saving + 0.14 Private Investment. All coefficients were highly significant. The main message from these exercises are that (i) the current

current account and its saving rate found in Section 1, accompanied by the relative stability of its investment rate. On top of this, as shown in the last row of Table 12, we tackled the alleged simultaneity of the private and public current accounts through a GMM system estimator, without perceiving worth mentioning changes.

Table 12
Fiscal Response to Private Sector Current Account Imbalances

Dependent Variable: Government Current Account	Corporate Current Account	Household Current Account
Random Effects	-0.362 (-8.33)***	-0.712 (-16.76)***
Fixed Effects	-0.362 (-8.17)***	-0.717 (-16.48)***
GMM System	-0.532 (-4.12)***	-0.833 (-4.31)***

We additionally investigate whether the government reacts symmetrically to household and corporate deficits and surpluses. In principle, we should expect a stronger response to deficits, as they are more likely to threaten macroeconomic stability than surpluses in a world of imperfect international capital markets. Our findings, reported in Table 13, contradict this hypothesis, once we witness that the countervailing effect is much higher for surpluses than for deficits. A political economy argument can be advanced: private deficits must be compensated with public surpluses, and governments often face political and social constraints to reduce expenditures and raise taxes –furthermore, financial crisis might not be such a central concern in mature economies as in emerging ones. Conversely, private surpluses easily allow governments to pursue expansionary policies (more spending and less taxes). Besides, the larger overall coefficient on household current account seems to be explained by the high sensitivity to surpluses (above 0.8) –the reaction to deficits is similar for both corporate and household (about 0.35 under random and fixed effects, and non-significant under GMM system).

account targeting is done mostly through changes in public saving rather than investment, but (ii) government saving responds more strongly to private investment than to private saving.

Table 13
Fiscal Response to Private Sector Current Account Deficits and Surpluses

	Corporate Current Account (Deficit)	Corporate Current Account (Surplus)	Household Current Account (Deficit)	Household Current Account (Surplus)
Random Effects	-0.352 (-5.79)***	-0.482 (-4.05)***	-0.388 (-3.15)***	-0.794 (-14.99)***
Fixed Effects	-0.342 (-5.55)***	-0.511 (-4.24)***	-0.378 (-3.06)***	-0.804 (-14.85)***
GMM System	-0.292 (-1.27)	-0.995 (-4.51)***	-0.487 (-1.26)	-0.95 (-4.73)***

An additional research question is whether institutional sectors seem a priori financially unconstrained because they are able to easily tap international capital markets (high international capital mobility) or because they finance each other through internal capital markets (high domestic capital mobility). Since we do not have information on intersectoral financial flows, we are forced to conjecture. Regarding household and corporate current accounts, the fact that the former is typically positive and the latter negative suggests that well-functioning internal capital markets are probably behind the low estimates of β_h and β_c.[10] We are less confident, though, that they have anything to do with financial flows with the public sector as, in spite of its effort to smooth external imbalances, the public sector normally exhibits deficits.[11]

In sum, we are inclined to believe, resting on our battery of FH tests, that OECD countries do not appear to face neither international financial constraints (as the positive national coefficients are just caused by a fiscal current account targeting policy) nor domestic financial constraints (as most sectoral FH coefficients are low and/or non-

[10] It could be the case that households channel their surpluses to foreign markets, but the strong (yet declining) financial home bias documented in numerous studies (see Lewis (1999)) leads to discard this possibility.

[11] Furthermore, unlike corporate and, especially, household surpluses, fiscal surpluses do not necessarily transform themselves into domestic private sector financing via the financial system, as far as those funds are often used to building up the stock of official net foreign assets.

significant).[12] However, as shown next, even this conclusion lends itself to further controversy.

Section 4: Deficits, Surpluses, and the Feldstein-Horioka Puzzle

The basic notion behind FH is that investment and saving move in tandem because the country or sector cannot invest beyond the amount of own resources it disposes of. This opens up the possibility of asymmetric correlations under current account deficits and surpluses. We should expect that investment would not deviate much from saving when facing a deficit under less-than-full capital mobility, but there is no reason to predict the same close relationship under a surplus, as saving can be as much larger than investment as desired.[13] To test the hypothesis, we created two annual dummy variables, with value 1 if a current account deficit (surplus) is observed, and 0 otherwise, which we then interacted with the saving rate. A positive and larger coefficient is expected on the Deficit vis-à-vis the Surplus resulting explanatory variables. Table 14 shows the estimates obtained by the same methods used in earlier sections, confirming our belief: FH correlations are in general much stronger for deficit than for surplus years –although the coefficient on corporate deficits is not significant in the GMM regression. As in previous sections, we find higher values at the national level vis-à-vis sectoral levels and, once again, the government sector happens to yield non-positive correlations in all cases.

Nevertheless, the exercise raises the question as to why some sectoral coefficients become significant and larger compared with the baseline ones, and not only for the Deficit variable but also for the Surplus variable. For the Deficit variable, the correlation climbs to around 0.5 for households and to 0.3 for corporations, while for the Surplus variable, it reaches about 0.2 for households but stays non-significant for corporations (save for the significant 0.1 with the random effects estimation). Scatter plots, in Charts 1 through 12, of sectoral investment and saving for Deficit, Surplus and

[12] Incidentally, the high degree of domestic capital mobility is consistent with the nil or negative estimates found in most intranational, provincial-level FH studies (see Hericourt and Maurel (2005) for a survey).

[13] Of course, the latter assertion relies on the realistic assumption that there are no capital controls limiting financial investment for surplus units, which became the predominant case in the sample from the early 1970s, when our sample begins –until then, controls were in place in some countries for investments abroad.

total figures provide us with a partial clue to disentangle this striking fact.[14] From visual inspection, we find that, as expected, many Deficit values (Surplus values) appear in the upper left (lower right) quadrant, so that the goodness of fit is stronger when they are taken as separate explanatory variables. But this is not just a misleading optical illusion, but an interesting economic phenomenon that urges us to partially revise our earlier results and to pinpoint three outcomes. First, the recovered significance of the FH correlation for deficit figures implies that financial constraints do seem to exist at the end of the day for the household and corporate sectors every time investment exceeds saving. Even though the estimates are in the lower bound within the empirical FH literature, they are still far from negligible. Furthermore, the higher correlation for household vis-à-vis corporations looks a priori reasonable, once one should believe the average household to be more financially constrained than the average corporation because of differences in size, age, and available collateral, all of which have a bearing on intermediation costs and the extent of informational asymmetries. These frictions become especially acute in international borrowing, where exchange rate uncertainty, exacerbated informational problems, and judicial and institutional barriers are at play – indeed, households rarely access international credit markets.

The second and more intricate fact is the upward slopping cloud of points for household surplus values, which is certainly not what the standard theory predicts regarding the separation of investment and saving decisions in the absence of financial constraints. Even though, as mentioned above, the correlation coefficient is rather low, it is highly significant and robust, thus deserving some brief analysis. The obvious candidate for explaining this is, once more, the influence of common factors on saving and investment, but we can quickly reject it after recalling that common factors did not appear to drive our baseline results. Anyway, we repeated the procedure of Section 2 and ran individual regressions of investment and saving on GDP growth, the inflation rate and per capita GDP for deficit observations, on one hand, and for surplus observations, on the other hand, and then computed the FH coefficient for the corresponding residuals. Had the surplus coefficient dropped significantly, there would have been some ground to blame common factors for the positive correlation in surplus

[14] Recall that the Deficit and Surplus variables are the interaction of saving rates with dummies variables. The observations lined up along the vertical axis in sectoral graphs correspond to zero values of such dummies.

times, but the (unreported) results were similar to the previous ones. A plausible alternative rationale is that, in simultaneously deciding saving and investment, each sector would be trying not to run excessive surpluses. After all, sacrificing current consumption pays off as long as the ensuing wealth accumulation allows economic units to avoid undesirable fluctuations in future consumption and investment. In this view, economic agents likely set an optimal rate of wealth accumulation based, among other factors, on their current wealth stocks, their forecasted income volatility, and their attitude towards risk. Once reached this optimal level, agents would prefer raising their consumption rather than their wealth, limiting their current account surpluses and strengthening the investment-saving correlation.

Finally, it catches the eye that national FH correlations increase compared to the baseline ones, owing to the same splitting just discussed. But the higher correlation for deficit (about 0.75) vis-à-vis surplus observations (about 0.55) appears at odds with the fiscal view put forward in Section 3. Our claim was that the national FH coefficient was expected to be larger the higher the negative correlation of public and private current accounts. Since the fiscal compensation coefficient was seen to be higher for private surpluses than for deficits, we would expect a higher coefficient in the former case.[15] However, we should recall that now, unlike the baseline ones, some sectoral FH correlations are significantly positive. As this is especially true for deficit years, this pushes up the national FH coefficient, thus partially counterbalancing the fiscal effect.

Table 14
FH Correlations for Deficit and Surplus Years

	Random Effects	Fixed Effects	GMM System
National (Deficit)	0.742 (22.92)***	0.695 (19.89)***	0.766 (9.75)***
National (Surplus)	0.558 (18.72)***	0.513 (15.59)***	0.539 (7.85)***
Household (Deficit)	0.536 (11.32)***	0.524 (10.9)***	0.456 (1.27)
Household (Surplus)	0.221 (10.37)***	0.216 (9.69)***	0.192 (2.6)**
Corporate (Deficit)	0.301 (5.93)***	0.249 (4.82)***	0.344 (2.32)**
Corporate	0.101	0.057	0.072

[15] For the private sector as a whole, the fiscal reaction coefficients are -0.23 for private deficits and -0.82 for surpluses.

(Surplus)	(2.35)**	(1.28)	(0.77)
Government (Deficit)	-0.004 (-0.27)	-0.007 (-0.52)	-0.04 (-1.18)
Goverment (Surplus)	-0.01 (-0.97)	-0.014 (-1.3)	-0.066 (-6.2)***

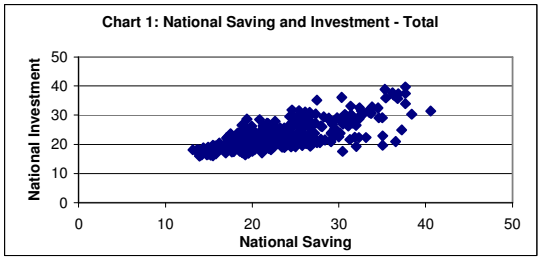
Chart 1: National Saving and Investment - Total
National Investment
National Saving
0
10
20
30
40
50

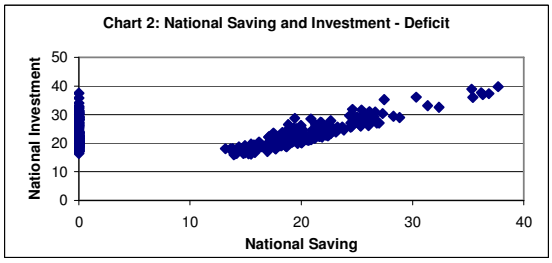
Chart 2: National Saving and Investment - Deficit
National Investment
National Saving
0
10
20
30
40

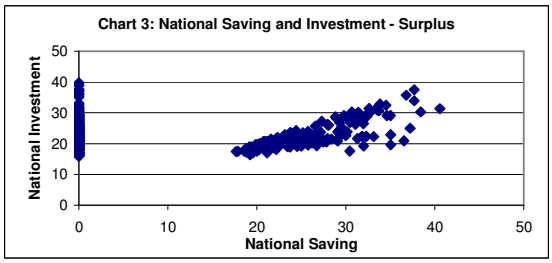
Chart 3: National Saving and Investment - Surplus
National Investment
National Saving
0
10
20
30
40
50

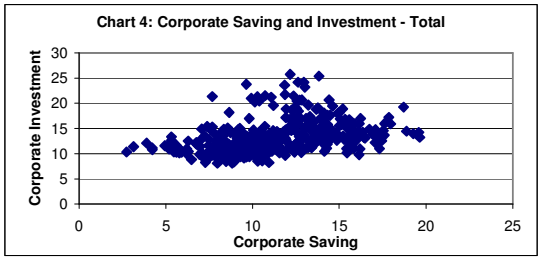
Chart 4: Corporate Saving and Investment - Total
Corporate Investment
Corporate Saving
0
5
10
15
20
25
30

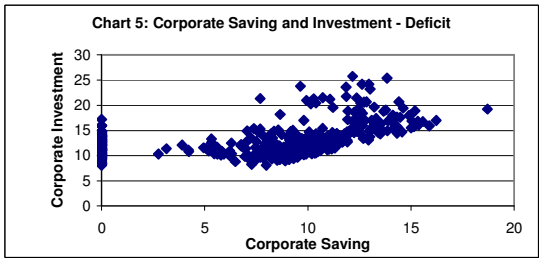
Chart 5: Corporate Saving and Investment - Deficit
Corporate Investment
Corporate Saving
0
5
10
15
20
25
30

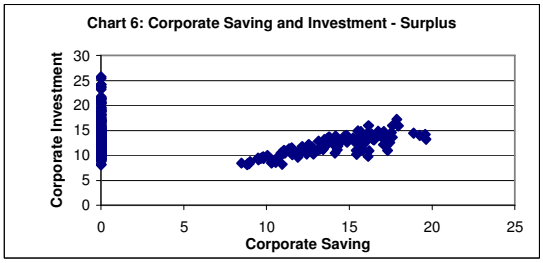
Chart 6: Corporate Saving and Investment - Surplus
Corporate Investment
Corporate Saving
0
5
10
15
20
25
30

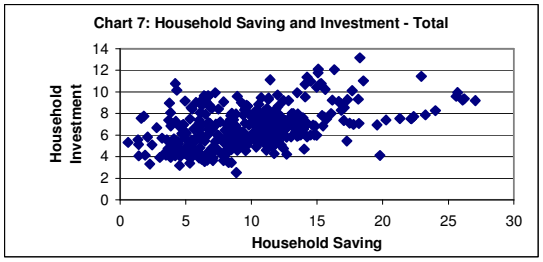
Chart 7: Household Saving and Investment - Total
Household Investment
Household Saving
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30

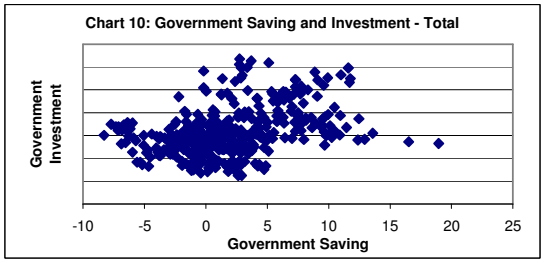
Chart 10: Government Saving and Investment - Total
Government Investment
Government Saving
-10
-5
0
5
10
15
20
25

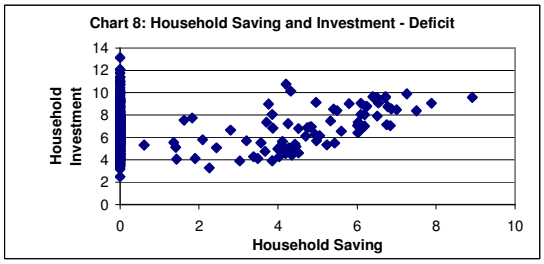
Chart 8: Household Saving and Investment - Deficit
Household Investment
Household Saving
0
2
4
6
8
10
12
14
0
2
4
6
8
10

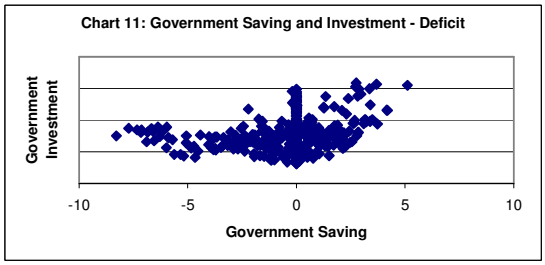
Chart 11: Government Saving and Investment - Deficit
Government Investment
Government Saving
-10
-5
0
5
10

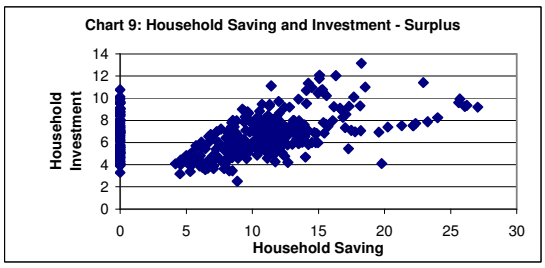
Chart 9: Household Saving and Investment - Surplus
Household Investment
Household Saving
0
2
4
6
8
10
12
14
0
5
10
15
20
25
30

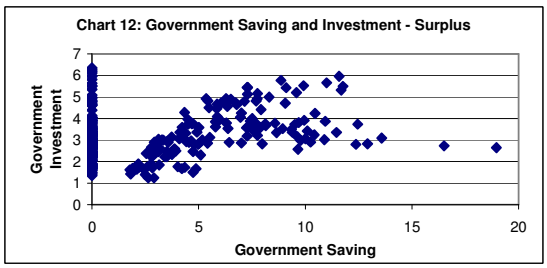
Chart 12: Government Saving and Investment - Surplus
Government Investment
Government Saving
0
1
2
3
4
5
6
7
0
5
10
15
20

Section 5: Intertemporal Budget Constraint and the Feldstein-Horioka Puzzle

Perhaps the most popular explanation for the strong correlation between saving and investment is that a country must meet its budget constraint in the long run, so current account deficits (surpluses) will be compensated by future surpluses (deficits). We study this issue by looking at the total and sectoral investment-saving relationships in the long- and short-run using the Pooled Mean Group (PMG) methodology, adopting a ARDL (1,1) structure.[16] This methodology is appealing because it enables to distinguish long-run and short-run effects in panel data, testing at the same time whether there is long-run homogeneity across units while maintaining short-run country heterogeneity. We offer additional details on this technique in the context of our present application in the Annex. We will work with unconditional Feldstein-Horioka regressions because the core of the argument revolves around the observed levels of investment and saving, no matter what underlying factors explain them.

The regression output appears in Table 15. Regarding total investment and saving, our first finding is that the long-run relationship is 0.75, with a lower short-run response of 0.25. The negative error correction term of 0.29 ensures the stability of the model and shows that half of the adjustment takes place in just 2.4 years.[17] Does the rejection of the hypothesis that the long-run coefficient is equal to 1 immediately mean that the intertemporal budget constraint is not satisfied? Our answer is no, as the notion of long run is somewhat arbitrary for a country, whose planning horizon is quite long. Particularly, for industrial countries, current account imbalances are observed for extended periods of time.[18] In the end, the need to have a balanced current account over rather short periods obeys to reputational considerations in international markets, which affect more heavily developing countries. At any rate, our sample does not look long enough to expect a one-to-one relationship between saving and investment in OECD countries. It must also be noted that the fact that the coefficient is not above 1 guarantees that the stock of external debt does not grow unboundedly.

[16] Results were not sensitive to the change in the lag structure.
[17] Also using PMG, Pelgrin and Schich (2004) find for a balanced sample of 20 OECD countries a long-run coefficient of 0.93 for 1960-1999 and 0.92 for 1970-1999, with an error correction estimate of -0.33 in both cases and short-run effects of 0.25 and 0.22.

All the sectoral long-run results are well below 1, with the corporate sector in the upper limit (0.58) and the household and government sectors in the lower one (0.078 and 0.062, respectively). In all cases, the error correction term is negative, as surprisingly are the short-run impacts. According to the Hausman test, the long-run parameter homogeneity cannot statistically be rejected in any of the equations, even though country-specific short-run responses vary in a noticeable fashion.[19] This homogeneity constraint explains the efficiency gains of the PMG over the MG reflected in the lower standard deviations of the estimates.

At this point we are concerned about the different long-run coefficient across sectors. For the non-significant government coefficient, the most sensible motive is that sovereign borrowers, especially in developed countries, enjoy a reputational and tax-levying advantage over private borrowers in local and foreign capital markets, which allows them to issue debt with much longer maturities and easy rollover. As for the difference between the corporate and the household sector, our main hypothesis goes along the same lines as those sketched in Section 4: the time frame to meet the intertemporal budget constraint is different for deficit and surplus economic units. Our previous analysis documented that financial constraints do arise once investment exceeds saving. In our sample, households are typically surplus units and corporations are deficit units.[20] In this light, the corporate sector is forced to, at least partially, repay its debt in the long-run, creating a positive nexus between investment and saving. The surplus household sector, on the contrary, is in position to decide more freely its saving and investment rates not only in the short- but also in the long-run.[21] A complementary reason that warrants the less-than-unitary coefficient is an aggregation issue: while the government is both a sector and a legal unit per se, there are millions of corporations and households. As a result, even though each of them may satisfy their own budget constraints, the sector as a whole may look as if not. In a simplistic example, suppose non-overlapping corporations living each just one period. At the end of the first period,

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[18] A case in point, among others, is Australia, whose current account has been strongly negative in all but 18 years since 1861 (see Cashin and Wickham (1998)).

[19] For space reasons, the short-run coefficients are not reported, but are available from the authors upon request.

[20] Over the total sample of 390 observations, a current account deficit was recorded in 55 cases (14.1%) for households and in 276 cases (70.8%) for corporations.

[21] Of course, in the long-run (whatever long-run means in our intertemporal problem) households have to satisfy their transversality condition (not leaving unconsumed wealth), unless bequests or other motives cause them to deviate from it.

the first company pays its debt and ceases to exist, but simultaneously the second one starts up and raises debt. Going on and on, corporate debt as a whole will not necessarily go down, regardless of the fact that each individual company respects its budget constraint in the short-run.[22] In our particular empirical application, this atomization blurs to some extent the long-run analysis on the household and corporate sectors.

Of importance here is also to underline that the fiscal view is still valid here: if the government targets the current account –as advanced in Section 3-, then the long-run national coefficient may be high even if the country is not required to meet its intertemporal budget constraint.[23] In consequence, the presence of a national coefficient higher than each and every sectoral long-run FH coefficient can be interpreted as before, with the additional upward influence of the high and positive corporate sector coefficient.

To close, it is worth noting that the cross-section regressions, a crude approximation to the long-run relationship, yield estimates of 0.59, 0.51, 0.19 and 0.16 for the national, corporate, household and government equations, somewhat similar to the PMG long-run coefficients of 0.75, 0.58, 0.078 and 0.062.

[22] The usually growing levels of domestic credit to the private sector in most countries is an eloquent piece of evidence of this kind of heterogeneity at the interior of the corporate and household sectors.
[23] But this does not work the other way around, as a high long-run coefficient does not necessarily imply a high short-run coefficient.

Table 15: Feldstein-Horioka Sectoral Regressions (Pooled Mean Group)

	Pooled Mean Group	Mean Group	Hausman Test (p-value in parenthesis)	Dynamic Fixed Effects
Total Saving Rate				
Long-Run Coefficient (Total Saving)	0.750 (10.021)***	1.052 (4.488)***	1.84 (0.17)	0.709 (4.583)***
Error Correction Coefficient	-0.291 (-7.431)***	-0.337 (-9.950)***		-0.278 (-6.361)***
Short-Run Coefficient (Δ Total Saving)	0.253 (2.510)**	0.193 (2.138)**		0.131 (1.009)
Constant	1.437 (3.998)***	0.491 (0.363)		
Household Saving Rate				
Long-Run Coefficient (Household Saving)	0.078 (2.233)**	-0.901 (-1.176)	2.75 (0.10)	0.394 (1.12)
Error Correction Coefficient	-0.229 (-5.105)***	-0.261 (-5.517)***		-0.159 (-5.841)***
Short-Run Coefficient (Δ Household Saving)	-0.129 (-1.382)	-0.106 (-1.186)		0.499 (3.142)***
Constant	1.364 (3.831)***	1.552 (4.847)***		
No. of Countries	16	16		16
No. of Observations	374	374		374

Note:
T Statistic in parenthesis ***Significant at 1%, **Significant at 5%, *Significant at 1%.

Table 15: Feldstein-Horioka Sectoral Regressions (Pooled Mean Group) (Cont.)

	Pooled Mean Group	Mean Group	Hausman Test (p-value in parenthesis)	Dynamic Fixed Effects
Corporate Investment Rate				
Long-Run Coefficient (Corporate Saving)	0.585 (5.451)***	6.286 (1.168)	1.12 (0.29)	0.439 (3.257)***
Error Correction Coefficient	-0.337 (-12.291)***	-0.337 (-8.727)***		-0.329 (-9.75)***
Short-Run Coefficient (Δ Corporate Saving)	-0.214 (-2.96)***	-0.231 (-3.144)***		-0.081 (-1.09)
Constant	1.99 (9.6)***	1.187 (1.036)		
Government Investment Rate				
Long-Run Coefficient (Government Saving)	0.062 (4.451)***	1.72 (1.117)	1.16 (0.28)	0.083 (2.759)***
Error Correction Coefficient	-0.233 (-7.84)***	-0.284 (-6.306)***		-0.194 (-6.733)***
Short-Run Coefficient (Δ Government Saving)	-0.049 (-3.066)***	-0.058 (3.030)***		-0.051 (-6.151)***
Constant	0.678 (5.828)***	0.748 (5.426)***		
No. of Countries	16	16		16
No. of Observations	374	374		374

Conclusions

Our goal in this paper was to re-examine the so-called Feldstein-Horioka puzzle introducing several data, economic and statistical innovations. Our findings, some of which question established assumptions and previous results in the literature, can be summarized as follows: (i) The national Feldstein-Horioka coefficient is in the vicinity of 0.5, but sectoral coefficients are much lower and even insignificantly different from zero; (ii) Such positive and significant national coefficient would not reflect frictions in international credit markets but just a fiscal current account targeting policy; (iii) Nevertheless, when the sample is split into deficit and surplus years, a higher and significant correlation emerges for the former at the national, household, and corporate level, implying that credit imperfections still play a role for the private but not for the public sector. Equally noteworthy, household correlation is still positive and significant, yet lower, for surplus years; and (iv) Against the background of a unitary long-run coefficient to satisfy the intertemporal budget constraint, the long-run relationship is 0.75 for national data, 0.6 for the corporate sector, and marginally or non-significant at the household and government level.

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Annex: GMM and PMG Estimators

Two modern dynamic panel data procedures are employed along with the more usual random and fixed effect techniques, namely, the Generalized Method of Moments (GMM) and the Pooled Mean Group (PMG) estimators. Given their relative novelty in the applied macroeconomic field, we devote a few lines to explain how they work.

GMM has two evident advantages: first, it allows to deal with the inconsistency created by the presence of the lagged dependent variable as a regressor; second, it allows to relax the assumption of strict exogeneity of the explanatory variables. Our basic regression will be of the form:

$$inv_{i,t} = \beta_1 inv_{i,t-1} + \beta_2 sav_{i,t} + \mu_i + \varepsilon_{i,t} \qquad i = 1, ..., N \qquad t = 1, ..., T$$

where *inv* is the investment rate, *sav* is the saving rate, *i* stands for each of the N cross-section units, t represents each of the T time-series units, β_1 and β_2 are scalar, μ_i and $\varepsilon_{i,t}$ are an individual-specific effect and an error term, respectively, with zero mean and constant and finite variance and independent of each other.

A major drawback with this specification is that the introduction of the lagged dependent variable as an explanatory variable gives rise to biased and inconsistent estimators. The reason is that both $inv_{i,t}$ and $inv_{i,t-1}$ are functions of μ_i. By first-differencing the previous equation, it is possible to account for the unobserved individual effects to obtain:

$$inv_{i,t} - inv_{i,t-1} = \beta_1 (inv_{i,t-1} - inv_{i,t-2}) + \beta_2 (sav_{i,t} - sav_{i,t-1}) + (\varepsilon_{i,t} - \varepsilon_{i,t-1})$$

It can be observed that there still is correlation between the lagged dependent variable and the new error term. If the error $\varepsilon_{i,t}$ is serially uncorrelated $[E(\varepsilon_{i,t}\varepsilon_{i,s})=0$ for $t \neq s]$, values of *inv* lagged two periods or more are valid instruments, so for $t \geq 3$ the following linear moment restrictions are satisfied:

$$E[(\varepsilon_{i,t} - \varepsilon_{i,t-1}) inv_{i,t-2}] = 0 \qquad t = 3, ..., T$$

Furthermore, we will assume that the saving rate weakly exogenous, meaning that future (but not necessarily contemporaneous and lagged) realizations of the error term are uncorrelated with the x set. Formally, $E(sav_{i,t}\varepsilon_{i,s})\neq 0$ for $t\geq s$ and $E(sav_{i,t}\varepsilon_{i,s})=0$ otherwise. This suggests that values of x lagged two periods or more serve as instruments, with the associated additional linear moment restrictions:

$$E[(\varepsilon_{i,t}-\varepsilon_{i,t-1})sav_{i,t-2}]=0 \qquad t = 3, ..., T$$

Arellano and Bond (1991) develop a consistent Generalized Method of Moments (GMM) estimator from these moment restrictions. This method has the additional advantage that does not rely on any particular probability distribution. Moreover, they distinguish a one-step and a two-step estimator, the difference being that in the latter case the residuals from the former are used to reestimate the coefficients.

Nonetheless, Blundell and Bond (1998) notice that lagged levels of the dependent variable may become poor instruments as far as this variable is highly persistent over time –as a matter of fact, the estimated coefficient is biased toward zero when the autorregressive parameter approaches one. In such a case, lagged differences of the dependent variable can serve as suitable instruments in the level regressions, provided this new instrument is uncorrelated with the fixed effect, which in turn require that the dependent variable be mean stationary. All this boils down into an additional set of moment restrictions:

$$E[(inv_{i,t-1}-inv_{i,t-2})(\eta_i+\varepsilon_{i,t})]=0$$
$$E[(sav_{i,t-1}-sav_{i,t-2})(\eta_i+\varepsilon_{i,t})]=0 \qquad t = 3, ..., T$$

By stacking the equations in differences with the equations in levels, a GMM system estimator results with superior performance in terms of unbiasedness and asymptotic efficiency.

An additional issue we would like to address is whether short- and long-run effects can be distinguished. Standard panel data techniques restrict the estimated coefficients to be the same for all cross-section units, allowing at most for group-specific intercepts by

using fixed-effects. At the other extreme, in the case of full panel heterogeneity, a mean group (MG) estimator -the average of the estimated coefficients from separate equations for each group- is consistent. Since in most cases we should expect parameter homogeneity in the long-run but not in the short-run, an intermediate estimator should be considered. The Pooled Mean Group (PMG) estimator developed by Pesaran, Shin and Smith (1999) appears as a sensible alternative. If the long-run homogeneity constraint is valid, the PMG will be consistent and efficient, but if it is not, it will be, unlike the MG estimator, inconsistent. This constraint can be tested with a Hausman test on each explanatory variable. Another caveat of the MG estimator is that, when the time and cross-section dimensions are short, it is quite sensitive to outliying country estimates. This comes from the fact that the MG estimator is an unweighted average of individual group estimators, and thus it suffers from the same problem as any average. The PMG estimator is more akin to a weighted average. Specifically, the method first estimates the common or pooled long-run coefficients, and then uses them to estimate the short-run coefficients and the speed of adjustment. The unweighted average of all these estimates is a consistent estimate of the short-run effects.

Suppose that the investment rate follows an autorregressive, distributed lag (ARDL) process of order (1, 1):

$$inv_{it} = \mu_i + \beta_1 inv_{i,t-1} + \beta_2 sav_{it} + \beta_3 sav_{i,t-1} + \varepsilon_{it}$$

Substracting $inv_{it,-1}$ from both sides and adding and substracting $\beta_3 sav_{it}$ in the right-hand side, we obtain the error correction equation:

$$\begin{aligned}\Delta inv_{it} &= -(1-\beta_1)\left[inv_{i,t-1} - \frac{\mu_i}{(1-\beta_1)} - \frac{(\beta_2+\beta_3)}{(1-\beta_1)} sav_{it} \right] + \beta_3 \Delta sav_{it} + \varepsilon_{it} \\ &= -(1-\beta_1)\left[inv_{i,t-1} - s^*_{it} \right] + \beta_3 \Delta sav_{it} + \varepsilon_{it}\end{aligned}$$

where s^* is the common long-run solution and Δ is the difference operator. The PMG first estimates the common long-run effects $\left[\mu_i /(1-\beta_1)\right]$ and $\left[(\beta_2+\beta_3)/(1-\beta_1)\right]$ to later on estimate the short-run coefficient β_3 and the speed of adjustment $\left[-(1-\beta_1)\right]$.