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Why the Feldstein–Horioka "puzzle" remains unsolved

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Abstract

We argue that the 40-year-old Feldstein–Horioka "puzzle" should have never been labeled as such. We discuss two problems with the literature. First, we show that the series of investment and saving rates typically used in empirical exercises to test the Feldstein–Horioka thesis are not appropriate. The correct series to properly test it are not collected. Second, we show that the Feldstein–Horioka regression is not a model in the econometric sense, that is, an equation with a proper error term (a random variable). The reason is that by adding the capital account to their regression, one gets the accounting identity that relates the capital account, domestic investment, and domestic saving. This implies that the estimate of the coefficient of the saving rate in the Feldstein–Horioka regression can be thought of as a biased estimate of the same coefficient in the accounting identity, where it has a value of 1. Because the omitted variable is known, we call it *pseudo bias*. Given that this (pseudo) bias is known to be negative and less than 1 in absolute terms, it should come as no surprise that the Feldstein–Horioka regression yields a coefficient between 0 and 1.

KEYWORDS
accounting identity, Feldstein–Horioka paradox (puzzle), investment, pseudo bias, saving

JEL CLASSIFICATION
F21, F32, F36, F41, E01, G15

1 | INTRODUCTION

Under conditions of perfect capital mobility, economic theory suggests that financial capital flows move across borders to seek the highest returns, equalizing real interest rates across countries (Fleming, 1962; Mundell, 1962, 1963). The Mundell–Fleming model provides an analytical framework to assess the effectiveness of fiscal and monetary and fiscal policies under different exchange rate regimes. In this model, capital flows are sensitive to interest rate differentials. Therefore, disparities between domestic and foreign interest rates are offset by the inflow (outflow) of capital into (out of) the domestic economy. The smaller the spread between domestic and foreign rates of interest, the greater is the mobility of capital across countries, and vice versa.

Feldstein and Horioka (1980) suggested using data on the saving–investment correlation to test the hypothesis of capital market integration. They proposed to estimate the following regression:

$$I_t = \alpha^* + \beta^* S_t + u_t \tag{1}$$

where I is gross domestic investment, and S is gross domestic saving, both as a percent of nominal GDP, and u is an error term. Underlying this regression is the classical view that saving finances investment and the loanable funds model.

The Feldstein and Horioka test was initially proposed as a test of world capital market integration, that is, as a measure of the degree of capital mobility across countries. If financial capital seeks the highest international returns, Feldstein and Horioka (1980) argued that β^* (referred to as the "retention coefficient") should be close to zero (though not necessarily zero) and certainly below one, that is, $0 < \beta^* < 1$.[1] This (null) hypothesis implies that investment is financed out of saving because capital is highly but not fully mobile. Equation (1) was estimated with data for 16 OECD countries with data for 1960–1974. Although the relationship in Equation (1) has often been referred to in the literature as a *correlation* (for obvious reasons), in reality, Equation (1) is thought of as a model. This is obvious in discussions in the literature about the need to use instrumental variable (IV) estimation, error correction models, or the need for additional regressors.

To their surprise, and this is the puzzle (FHP hereafter), β^* was close to one, which they interpreted as evidence that most savings were retained by the home country (or, lack of capital markets integration), with the average for all countries together being 0.89 in their base equation, and with a standard error of 0.07 (Feldstein & Horioka, 1980, p. 321). They obtained quantitatively and qualitatively similar results from estimating variations on Equation (1) that controlled for openness, size, economic growth, population age, and so forth. This result was reconfirmed by Feldstein (1983).[2] For this reason, the FHP was referred to by Obstfeld and Rogoff (2001) as one of the most significant and enduring anomalies in international macroeconomics.

[1] More precisely, perfect capital mobility results in variations in the proportion of investment financed by domestic saving relative to international saving as capital flows react quickly to changes in relative returns. This raises coefficient standard errors enough to not reject the null hypothesis that $\beta^* = 0$.

[2] Telatar et al. (2007) critiqued the original Feldstein and Horioka (1980) work because their regression coefficients were unstable as a result of policy regime changes, consistent with the Lucas critique.

The standard interpretation of the FHP is that domestic investment spending is financed mostly by domestic savings, with little financing from mobile international capital. The FHP is thus concerned with why domestic investment and domestic saving are correlated across countries in a world in which international financial markets very clearly move large amounts of financial capital between countries very rapidly every day. The anomaly is the coexistence of apparently mutually exclusive high saving–investment correlations with the observed high mobility of capital. Indeed, the Feldstein and Horioka finding (interpreted as capital immobility and imperfect integration of international financial markets) conflicts with the predictions of the Mundell–Fleming model (Fleming, 1962; Mundell, 1962, 1963), as well as with the postulates of financial globalization theory. The anomaly or puzzle remains unexplained today, given the large number of papers still being written, and the fact that one of the two original authors recently proposed a solution to it (Ford & Horioka, 2017).

We argue in this paper that there are two serious shortcomings with tests of the Feldstein–Horioka hypothesis, in particular through Equation (1) and variants of it. Together, they raise serious doubts about this literature, both conceptually and empirically. First, we show that saving, investment, and *net* financial flows data, as usually defined and measured in the national accounts and used to estimate Equation (1), are not appropriate for testing the Feldstein–Horioka hypothesis and capital mobility. Empirical tests of capital mobility in the Feldstein and Horioka literature inherently depend on how (and if) the transactions under consideration appear in official accounts. We show that a test of the Feldstein–Horioka hypothesis based on Equation (1) has the accounting wrong. With only a few exceptions (e.g., Borio & Disyatat, 2010, 2015; Shin, 2012), no study of the Feldstein and Horioka thesis has grounded the analysis in how the relevant transactions are recorded in national accounting. Our paper extends their arguments.

Second, we argue that there is an additional serious shortcoming with Equation (1) and variations of it. This equation can be interpreted as a special case of the national income accounting identity that relates domestic investment, domestic saving, and the capital account (hereafter, KA, assumed to include the standard statistical discrepancy), that is,

$$I_t \equiv S_t + KA_t \tag{2}$$

but with KA_t omitted. The symbol $\equiv$ indicates that Equation (2) is an accounting identity by construction. The identity of Equation (2) is obviously correct. The argument is that the identity poses a serious problem for the interpretation of β^* in Equation (1). We show that β^* obtained in Equation (1) is a biased estimate of the corresponding coefficient in the identity as a result of the omission of the capital account. Yet, because the omitted variable is known to the researcher, we refer to it as *pseudo bias*. This is not the standard omitted-variable bias. Economists familiar with the variables in Equation (2) ought to expect β^* to be similar to (most) authors' findings in the literature, that is, in general, larger than zero and less than one. Although Feldstein and Horioka were obviously aware of Equation (2) (as most of the profession), they did not see the implications for running a regression of Equation (1), namely that it is not a true regression model because the error term (u) is not an unknown but the capital account (KA). Although it is true that one does not know a priori the precise value of β^*, we show that it will fall within the range $0 < \beta^* < 1$ as a consequence of the identity. The problem discussed has no econometric solution.

The contribution of our paper to the literature is somewhat nihilistic, but important. We show that most of the empirical work undertaken during the past four decades to elucidate the puzzle is flawed, and, consequently, the question about the degree of capital mobility across countries remains unanswered. Our argument is that the data (series) and the econometric methods used are not suitable to answer the question. The literature has been stuck within these two drawbacks (without realizing it) for over 40 years.

The rest of the paper is structured as follows. Section 2 is provides a review of the literature. Section 3 discusses the problems with the series traditionally used to test the Feldstein and Horioka hypothesis. Section 4 discusses the econometrics of Equation (1), and Section 5 provides empirical evidence. Section 6 concludes that the Feldstein and Horioka argument is a hypothesis waiting to be properly tested. The Supporting Information Appendix elaborates further on the discussion in Section 5 by explicitly considering the statistical discrepancy in the capital account.

2 | LITERATURE REVIEW

The first part of this section provides a brief survey of the very large literature on the Feldstein and Horioka hypothesis. Most of the papers reviewed are concerned with the size of the saving-retention coefficient β^*. The discussion is organized mainly according to the finding (rejection or not of the hypothesis), and the theoretical approach used.[3] The second part offers a discussion of the theoretical foundations of the Feldstein and Horioka hypothesis.

2.1 | The size of the saving-retention coefficient: has the profession reached agreement?

Using regression (1) (or variants of it), many studies have found support for the initial Feldstein–Horioka finding of a strong relationship between savings and investment, that is, a high saving coefficient, which would signal a low capital mobility, especially using data for the advanced economies (e.g., Caporale et al., 2005; Coakley et al., 1996; De Vita & Abbott, 2002; Jansen, 1996; Levy, 2000; Moreno, 1997; Penati & Dooley, 1984).

From an econometric point of view, authors have interpreted the high coefficient as the result of "bias," and different procedures have been used to try to deal with it. The literature has pointed out, however, that a high saving-retention coefficient does not necessarily signal a low degree of financial integration. One explanation advanced was that common factors such as economic or population growth could co-determine both saving and investment rates. This would account for the observed high correlation, even in the presence of open capital markets (Obstfeld, 1985). A second explanation of the high coefficient was that policymakers may seek to attain a low current account balance through fiscal or balance of payments policies (Summers, 1985).

Many other studies, however, have not rejected the Feldstein and Horioka null hypothesis (i.e., a low or insignificant correlation between saving and investment rates) for some specific countries or groups of them, and for specific time periods (e.g., Armstrong et al., 1996; Blanchard & Giavazzi, 2002; Coakley et al., 2004; Dzhumashev & Cooray, 2016; Ghosh, 1995; Giannone & Lenza, 2008;

[3] Given our assessment of this work in Sections 3–5, we do not classify the studies according to the specific econometric methodology used. We simply mention that the initial studies conducted in the 1980s were predominantly cross-sectional and estimated Equation (1) using the standard OLS estimator. These models were commonly estimated on data averaged over time for the sample countries. In the late 1980s and 1990s, many authors used cointegration estimators and error-correction models in a time-series setting. These studies used both single-equation and vector autoregressions, and they also tend to find high saving coefficients. Since the mid-1990s, many authors have used panel data models. They find support for a considerable degree of capital market integration (i.e., a low saving retention coefficient).

Hoffmann, 2004; Holmes & Otero, 2014; Krol, 1996; Payne & Kumazawa, 2006; Pelgrin & Schich, 2008; Sinha & Sinha, 2004; Tesar, 1991). This would be a sign of high capital mobility. Studies using intranational regional data have also found that the null hypothesis in Equation (1) cannot be rejected (e.g., Boyreau-Debray & Wei, 2004; Hashiguchi & Hamori, 2009; Yamori, 1995).

The reality is that there is no agreement on what the size of the saving-retention coefficient is, as a more comprehensive review of the literature shows. Murphy (1984), for example, divided his sample of 17 OECD countries into 10 small and 7 large countries. For the latter group, he estimated a coefficient on the saving-retention rate of 0.98, whereas for the small-country group a coefficient of 0.59. He argued that the Feldstein–Horioka regression concerns two hypotheses: perfect capital mobility and small open economies. The reason is that small countries cannot influence world interest rates and prices, whereas large countries can, and so the latter can bias the saving–investment correlation toward one, even under conditions of perfect capital mobility. Dooley and Kletzer (1994) examined 48 developing and 14 OECD countries over two subperiods, 1960–1973, and 1974–1984. They found that the saving coefficient of the OECD countries was greater than that of the developing countries. The coefficients of the second subperiod were greater than those of the first one, for both groups. They also divided the developing countries into two groups: 21 market borrowers and 14 countries that depended on official financing. The saving–investment correlation was positive and significant when both groups combined. Moreover, the relationship was stronger in the second sub-period and for the market borrowers than for the official borrowers. Mamingi (1997) investigated the Feldstein–Horioka hypothesis using time series data for 58 developing countries. Overall, he found that the saving–investment coefficient was smaller than the corresponding coefficient in studies for the OECD countries. Vamvakidis and Wacziarg (1998) tested the hypothesis for 103 countries (full sample and split by income) for 1970–1993. They found a small coefficient, below 0.3 often, for any sample other than the OECD.

Coakley et al.'s (1998) survey noted that the Feldstein and Horioka high cross-section association between saving and investment rates in OECD countries was a robust result. Much less agreement existed on whether saving–investment comovements were truly informative about capital mobility.

Kim et al. (2005) investigated the hypothesis using data for 11 Asian countries for the period 1960–1998. They found that the coefficient ranged from 0.37 to 0.84. Kollias et al. (2008) examined the saving–investment correlation for the EU15 member countries, for the period 1962–2002. They found that domestic savings had little impact on investment. They also found the panel coefficient to be 0.148 for 15 countries. Pelgrin and Schich (2008) used data for 20 OECD countries for 1960–1999. The authors interpret the relationship between national saving and investment as reflecting a long-run solvency constraint (short-run current account imbalances cannot persist). They find that saving and investment are cointegrated, which is consistent with the interpretation that a long-run solvency constraint is binding for each country. Over time, however, deviations from this long-run equilibrium relation have become more persistent, which suggests that capital mobility has increased. Some papers that report inconclusive results. For example, Murthy (2009) examined 14 Latin American countries over 1960–2002 and found a saving coefficient that varied between 0.46 and 0.48.

Apergis and Tsoumas (2009, p. 73) also concluded their survey of the literature by arguing that: "…the majority of the aforementioned studies [econometric estimation] support a strong correlation between [domestic] savings and investment, albeit lower than that displayed in the earlier attempts," and, though important disagreements on appropriate tests of capital mobility remain, "the majority of the results do not clearly validate the capital mobility hypothesis."

Holmes and Otero (2014) tested the hypothesis for 25 OECD countries for 1970–2011. They estimated Equation (1) year by year (opposed to estimation using time-averaged data) and found that the saving-retention coefficient has gotten smaller. They argue that this is a sign that capital mobility has increased. They also estimate two additional regressions: current account (dependent variable) on the savings rate and current account on the investment rate. These regressions support this finding. They also suggest a lack of capital mobility, reflected in only domestic saving (significant), and not investment (insignificant), driving current account balances. Indeed, they argue that the insignificance of investment points toward capital immobility and suggests that current account deficits (surpluses) are the result of reduced (increased) domestic savings and not investment booms (slumps). Lastly, Kónya (2015) tested the hypothesis using data for Brazil, Russia, India, China, and South Africa, with data for 1960–2001. They found that the regression coefficient varied from 0.616 to 1.010 and reported that capital mobility in South Africa and Russia was higher than those in India, Brazil, and China.

A mirror way to analyze the relationship between savings and investment is to study the sustainability of current account deficits. These studies have also found high correlations between exports and imports, and thus cross-validated the existence of high correlations between saving and investment (Bergin & Sheffrin, 2000; Husted, 1992; Irandoust & Ericsson, 2004; Wu et al., 2001).

Frankel (1991, 1992) argued that if the goal is to test the degree of integration of capital markets rather than the extent to which domestic savings have crowded out investments, then it is better to look at rates of returns differentials. He proposed to test the international capital mobility hypothesis through the covered and uncovered interest parity. He argued that to properly test the Feldstein and Horioka (1980) thesis, researchers would have to use data free of currency premium. In these approaches, economic models and econometric tests look at differences in rates of returns (e.g., real interest rates) across countries instead of estimating saving–investment correlations. The broadest test looks at the mean and variability of real interest rates differential, $r - r^*$, where r is the domestic real interest rate, and r^* is the world's interest rate. Other tests look at the stationarity and possible co-integration of these differentials. The real rate differential can also be further decomposed to account for country and currency premiums. Frankel (1991) found that despite the equalization of covered interest rates, real interest rate differentials remain amidst the worldwide trend of financial integration.

Some authors opted to follow a different methodology to examine the puzzle. Instead of directly testing Equation (1), they constructed RBC or DSGE models (e.g., Bai & Zhang, 2010; Chang & Smith, 2014; Mendoza, 1991). These approaches provide solid microeconomic theory to the Feldstein–Horioka hypothesis by introducing theoretical channels to explain the high and statistically significant high correlations between savings and investment, which are an implication of a current account solvency constraint. The question, however, is whether these exercises are true tests of the original hypothesis or, rather, examples of artificially constructed economies that, under some parameter values, generate a low or high (depending on the values) correlation between saving and investment.[4]

[4] Bai and Zhang (2010) is one such example. They investigate the impact of two types of financial frictions on the Feldstein–Horioka high correlation puzzle. One is limited enforcement, where contracts are enforced by the threat of default penalties. The other is limited spanning, where the only asset available is noncontingent bonds. They find that the calibrated model with both frictions produces a savings-investment correlation and a volume of capital flows close to the data. To solve the puzzle, the limited enforcement friction needs low default penalties under which capital flows are much lower than those in the data, and the limited spanning friction needs to exogenously restrict capital flows to the observed level.

What is the state of the discussion today? In what is probably the most comprehensive survey of the Feldstein–Horioka hypothesis and puzzle, Singh (2016) reviewed over 100 articles. His summary clearly indicates mixed evidence that the conclusions obtained (i.e., rejection or otherwise of the Feldstein–Horioka hypothesis) depend on the methodology used and the countries tested. It is virtually impossible to come to single conclusion. A summary is as follows: (i) Some studies find high saving–investment correlations for the developed countries (indicating low international mobility of capital), and low saving–investment correlations for the developing countries (indicating high international mobility of capital) adding to the puzzle; (ii) studies accounting for structural breaks in model parameters support the view of a decrease in saving–investment correlations and an increase in international mobility of capital, after the switch from fixed to flexible exchange rate regime, and the removal of policy restrictions on capital flows; and (iii) the intertemporal optimization approach DSGE models mainly provide theoretical predictions and suggest that it is possible to find high saving–investment correlations in the wake of high international mobility of capital.

In a more up-to-date review of the empirical work on the topic, Pata (2018, p.970) correctly indicated that “the lack of agreement on the validity of the FH hypothesis by the studies in the literature is the result of differences in the examined period, country-country group and methods used.” He surveyed 22 studies on the topic and corroborated the lack of agreement. In his own analysis including seven countries (Brazil, China, India, Indonesia, Mexico, Russia, and Turkey), and using cointegration and causality tests, he also found diverse results (including a saving coefficient larger than 1 for India, which would indicate that it exports capital). Overall, he obtained high saving coefficients in the short and long term, thus reconfirming the puzzle. His results indicate that capital mobility is imperfect across these countries, and that capital inflows are restricted.

Finally, we mention that Ford and Horioka (2017) acknowledged the problems inherent in the depiction of international capital flows within Equation (1). Specifically, they wrote that “global financial markets cannot, by themselves, achieve net transfers of capital” (p. 95). This is a conceptual argument that did not require regression analysis (or other quantitative techniques). We elaborate on this point in the next section.

The conclusion of this review is that the mixture of results obtained testing the Feldstein and Horioka hypothesis does not allow any overall judgment. Reading the articles published on the subject, one cannot but feel that testing the Feldstein and Horioka hypothesis has become an industry. Whether authors corroborate or reject the hypothesis of capital mobility depends strongly on the methodology, countries, and time period, used. More than four decades have passed since the seminal contribution of Feldstein and Horioka (1980) and the profession has not reached consensus. Perhaps the answer lies somewhere else.

2.2 | The theoretical foundations of the Feldstein and Horioka hypothesis: how sound are they?

As shown above, most of the literature on the Feldstein and Horioka hypothesis and the FHP is empirical, with authors concerned with estimating “the correct” β^*. We find it somewhat sur-

When combined, the two frictions interact to endogenously restrict capital flows and thereby solve the Feldstein–Horioka puzzle.

prising that no author (to our knowledge) has questioned the theoretical underpinnings of this literature. Here, we offer three considerations:

1. As noted in the Introduction, the framework that underlies the Mundell–Fleming model and the Feldstein–Horioka hypothesis is the classical view that saving finances investment. Indeed, the econometrics of Equation (1) imply an equilibrium where saving finances investment and (in the case of alternatives such as error correction models) an adjustment process to a steady-state. The framework also rests on the notion that banks create money through the money multiplier.[5] These two imply that the money supply is exogenous (i.e., it increases as a result of an increase in deposits) and is determined by the Central Bank (i.e., by controlling the monetary base and setting the reserve ratio, the Central Bank is thought to be able to control the size of the money supply). We believe that this view does not reflect the reality (Wray, 1998). The latter is that banks borrow reserves in the interbank market, that banks make loans independently of their reserve position, and that monetary policy is conducted by the Central Bank setting a target interbank rate. In contrast to the classical view that deposits drive loans, we argue that loans drive (create) deposits. This implies that the money supply is endogenous in the sense that the supply of bank money is determined (endogenously) by the demand for bank loans, plus the willingness of banks to lend (which gives rise to the creation of deposits).
2. The intellectual framework of the Feldstein–Horioka hypothesis also relies on the loanable funds model, according to which equilibrium in the economy is achieved through interest rates adjustments, which always bring planned saving and planned investment into equality when households (HHs) and firms' preferences change. This means that the interest rate is determined in the market for loanable funds. It is the return to HHs for their saving and derives the cost of borrowing funds for investment purposes. Moreover, this framework assumes that there is a fixed pool of funds for which private and public sectors compete, and saving "finances" not only investment, but also fiscal and current account deficits. Again, we argue that the nation's policy interest rate is not set in this fashion, and that causation runs the other way around, that is, it is the investment, government, and export spending, which together create the domestic saving of the private sector and the foreign saving, in the form of the currency of issue.[6] In sum, investment creates saving.
3. As a consequence of the above, the widely held idea that saving from the rest of the world is a precondition for a country to spend is mistaken. The idea that a country needs to raise funds from a limited stock of accumulated savings from other countries in order to "finance" its spending is not true. Think of the United States. The current account deficit of the United States is not the result of credit in dollars provided by another country; rather, it is a credit in dollars issued by the only institutions authorized to issue dollars, namely, the US national banking system. The US current account deficit exists not because other countries lend their financial savings to the United States but because they demand dollars as reserves or private portfolios or means of payments.

[5] It also rests on Hume's specie-flow mechanism, according to which the balance of payments self-adjusts: with a fixed exchange rate, there will be an accumulation (depletion) of foreign exchange reserves; or appreciation (depreciation) of domestic currency under a flexible exchange rate system.

[6] In simple terms: A saver cannot ask his/her bank to credit a savings account. Yet, an investor can approach a bank for a loan, in which case the latter's deposit account will be credited and this transaction will be offset on the bank's balance sheet by the loan, which is the bank's asset. When the investor purchases plant and equipment, that deposit account is drawn down and a saver's account is credited.

We contend in the next sections that, on top of the theoretical considerations discussed above, the Feldstein and Horioka literature suffers from two crucial problems which question the soundness of this research program and which explain why the impasse is coming to a clear conclusion.

3 | THE SOLUTION TO THE FELDSTEIN–HORIOKA PUZZLE IS NOT FOUND IN OFFICIAL SAVING, INVESTMENT, AND CAPITAL ACCOUNT BALANCE DATA IN NATIONAL INCOME ACCOUNTS

The concern in this section is with the accounting behind the series used: if from Equation (2) and using the national income accounts, gross national saving, and the capital account are something other than accounting records of financing of gross domestic investment, then tests of Equation (1) and its variants are irrelevant for purposes of the Feldstein–Horioka hypothesis. More generally, although accounting is quite obviously not an economic theory, testing an economic theory requires consistency between the transactions the theory describes and the accounting underlying the transactions recorded in the real-world data investigators base the test upon.

The analysis here agrees with those of Borio and Disyatat (2010, 2015) and Shin (2012), who argued that saving and the capital account balance in the national income accounts are unrelated to accounting records of the financing of investment spending. Saving from the national income accounts is not a record of financing (Borio & Disyatat, 2010, p. 199) but rather the difference between income and spending, both private and government.[7] Although most economists argue that saving finances investment, at least in the long run, even if correct as a matter of causation, the accounting record of saving and investment will not show this. They likewise argued that "by construction, current accounts and net capital flows reveal little about financing. They capture changes in net claims on a country from trade arising in *real* goods and services" but "leave out trade in *financial* assets, which make up the bulk of cross-border financial activity" (p. 199; emphasis in original). We illustrate their points below through a series of examples.

Table 1 provides seven examples of transactions, each involving some combination of a domestic bank (US Bank—USB), a firm producing consumption goods (C Firm—CF), a firm producing capital goods (K Firm—KF), members of a HH employed by CF, a foreign bank (For Bank—FB), and a foreign firm that both produces and purchases capital goods (For Firm—FF). Transactions in each cell are denoted as follows (capital letters in the cells): (D) deposits; (Eq) equity; (C) cash; (K) capital goods; (CB) corporate bond; (L) loan.

The examples show that neither domestically sourced nor internationally sourced financing is a transaction that involves spending or a change in income for any parties involved. This means that savings, as defined in the national income accounts, cannot be the accounting record of domestically sourced financing of investment spending. Likewise, it also means that the capital account, as defined in national income accounts, cannot be the accounting record of internationally sourced financing of investment spending.

Example 1—The HH receives wages and saves by stashing cash in a mattress. In the T-accounts to accompany this example, CF pays wages to a member of HH, who decides to stash the cash in a mattress rather than consuming more. These are obviously two separate transactions. For the first (top row of entries), assuming that both keep accounts at a USB, this is a simple exchange of

[7] Some saving measures in national income accounts incorporate imputations of durable goods and capital consumption, of course, but this is also quite obviously not part of the accounting record of financing investment flows.

TABLE 1 Examples of transactions between various sectors.

US Bank (USB)		Consumption Goods Firm (CF)		Capital Goods Firm (KF)		Household (HH)		Foreign Bank (FB)		Foreign Firm (FF)	
A (assets)	L/E (liabilities/ equity)	A	L/E	A	L/E	A	L/E	A	L/E	A	L/E
Example 1—The household receives wages and saves by stashing cash in a mattress											
	$-D_{CF}$ $+D_{HH}$	$-D_{CF}$	$-Eq_{CF}$			$+D_{HH}$	$+Eq_{HH}$				
$-C_{USB}$	$-D_{HH}$					$-D_{HH}$ $+C_{HH}$					
Example 2—The household purchases a corporate bond from the consumption goods firm, issued to purchase capital goods from the capital goods firm											
	$-D_{HH}$ $+D_{CF}$	$+D_{CF}$	$+B_{CF}$			$-D_{HH}$ $+B_{CF}$					
	$-D_{CF}$ $+D_{KF}$	$-D_{CF}$ $+K_{CF}$		$+D_{KF}$ $-K_{KF}$							
Example 3—The consumption goods firm issues a corporate bond to the foreign bank to finance the capital purchase from the capital goods firm											
	$-D_{FB}$ $+D_{CF}$	$+D_{CF}$	$+B_{CF}$					$+B_{CF}$ $-D_{FB}$			
	$-D_{CF}$ $+D_{KF}$	$-D_{CF}$ $+K_{CF}$		$+D_{KF}$ $-K_{KF}$							
Example 4—The household purchases a corporate bond newly issued by the foreign firm; the foreign firm is refinancing a maturing loan from the foreign bank											
	$-D_{HH}$ $+D_{FB}$					$-D_{HH}$ $+B_{FF}$		$+D_{FB}$	$+D_{FF}$	$+D_{FF}$	$+B_{FF}$
								$-L_{FF}$	$-D_{FF}$	$-D_{FF}$	$-L_{FF}$
Example 5—The foreign firm uses its own deposits to purchase capital goods from the capital goods firm in the United States											
	$-D_{FB}$ $+D_{KF}$			$+D_{KF}$ $-K_{KF}$				$-D_{FB}$	$-D_{FF}$	$+K_{FF}$ $-D_{FF}$	
Example 6—The consumption goods firm issues a corporate bond to the household in order to purchase capital goods from the foreign firm											
	$-D_{HH}$ $+D_{CF}$	$+D_{CF}$	$+B_{CF}$			$-D_{HH}$ $+B_{CF}$					
	$-D_{CF}$ $+D_{FB}$	$-D_{CF}$ $+K_{CF}$						$+D_{FB}$	$+D_{FF}$	$+D_{FF}$ $-K_{FF}$	
Example 7—The household purchases the foreign firm's corporate bond, issued to finance a purchase from the capital goods firm											
	$-D_{HH}$ $+D_{FB}$					$-D_{HH}$ $+B_{FF}$		$+D_{FB}$	$+D_{FF}$	$+D_{FF}$	$+B_{FF}$
	$-D_{FB}$ $+D_{KF}$			$+D_{KF}$ $-K_{KF}$				$-D_{FB}$	$-D_{FF}$	$-D_{FF}$ $+K_{KF}$	

Note: Capital letters in the cells stand for the following: (D) for deposits; (Eq) for equity; (C) for cash; (K) for capital goods; (CB) for corporate bond; (L) for loan.
Source: Authors.

USB's deposits (liabilities of USB) from the employer's account to the employee's account ($-D_{CF}$ and $+D_{HH}$). In CF's T-account, this is a reduction in deposits as well as in its equity ($-Eq_{CF}$) because wages are a cost that reduces profits and thus retained earnings, ceteris paribus, whereas for HH, this is an increase in both ($-Eq_{HH}$). For the second transaction, HH withdraws the full amount ($-D_{HH}$) as cash ($-C_{USB}$ and $+C_{HH}$).

For national accounts, it is the first transaction that is an increase in HH's savings—as well as an offsetting reduction in CF's savings—not the second transaction because HH receives income but does not raise spending. HH's increased saving is thus a residual of its increased income, not a financing transaction. In the second transaction, the HH stuffs the currency in the mattress, which is obviously not the accounting record of financing investment. Instead, it is the allocation of its new savings.[8]

Example 2—The HH **purchases a corporate bond from the consumption goods firm, issued to purchase capital goods from the capital goods firm**. Here HH purchases a corporate bond from CF ($+B_{CF}$, top transaction). CF then purchases capital goods ($+K_{CF}$) from KF (bottom transaction). Like the second transaction in Example 1, the top transaction is a reallocation of HH's savings, in this case, from deposits to the bond. The second transaction, however, is both a rise in investment spending by CF and a rise in saving by KF (ceteris paribus).

Note that HH's lending and CF's borrowing in the top transaction do not affect saving in the national income accounts because lending and borrowing transactions are neither spending nor exchanges of income. Saving is a residual of income inflows not matched by spending or other transfer payment outflows that raises the payee's income directly—a change in one's saving thus requires a change in one of those. The accounting record for lending and borrowing changes none of them. Consequently, borrowing and spending are separate transactions in terms of their respective accounting; lending and saving are also similarly separate accounting transactions. This means that saving and investment data are inapplicable to a test of how much domestic investment is financed domestically because "financed domestically" is not what "domestic saving" in the national income accounts actually measures.

As the identity in Equation (2) shows, gross domestic saving is not equal to gross domestic investment whenever the capital account balance is nonzero. The examples below incorporate accounting of international capital flows to illustrate when the capital account balance does and does not change.

Example 3—The consumption goods firm issues a bond to the foreign bank to finance the capital purchase. This example assumes CF issues the bond to FB to finance the capital goods purchase. In the first transaction, FB uses a deposit ($-D_{FB}$) at a USB to purchase the bond from CF. This is the sort of mobility of international capital that Feldstein and Horioka were attempting to uncover through the estimation of Equation (1). In the second transaction, as in Example 2, CF purchases the capital goods from KF. Once again, according to the national income accounts, only in the second transaction is there a rise in saving. In other words, it is an increase in gross domestic savings, not foreign savings, that accompanies the investment spending in national accounts. There is no net change to FB's total claims on US entities and thus no net financial flow recorded from FB.

[8] Note the distinction between saving (without an "s") and savings (with an "s"). Saving is a residual from income flows. Savings is a stock of assets, as in a "savings account." Many in the FHP literature instead appear to use the terms interchangeably, perhaps unsurprisingly so given the lack of explicit description of the accounting for transactions under consideration.

Together, Examples 2 and 3 present the two scenarios that regressions of Equation (1) attempt to distinguish—domestic capital investment spending financed domestically in Example 2 or financed via internationally mobile capital inflows in Example 3. The crucial takeaway is that in both examples, it is domestic saving that increases in the national income accounts—the national income accounting data used to estimate Equation (1) is unrelated to the issue of whether financing originates domestically or internationally. This illustrates Shin's (2012) claim that the accounting record of international capital mobility, to the degree it is even available, is in the gross changes to specific financial assets held by investors in other countries, not net financial flows that are represented by the capital account balance.[9]

Example 4—The HH **purchases a bond newly issued by the foreign firm; the foreign firm is refinancing a maturing loan from a foreign bank**. Here HH now purchases FF's bond ($+B_{FF}$) in the first transaction, and FF uses the proceeds to pay down a maturing loan at FB ($-L_{FF}$) in the second transaction. The national income accounts record no changes in saving or in the capital account balance of either nation because there is neither spending nor changes in incomes of those involved.[10] This example illustrates that purely financial transactions across national borders do not change net positions recorded in the current and capital account balances.

Example 5—The foreign firm uses its own deposits to purchase capital goods from the capital goods firm in the United States. In this example's sole transaction, FB debits FF's deposits ($-D_{FF}$) that pay for the capital goods ($+K_{FF}$). In turn, USB credits KF's deposits ($+D_{KF}$). To settle the payment among the banks, FB's account at USB is debited ($-D_{FB}$) (equivalently for net capital flows accounting, the example could have credited USB's account at FB instead).

Of main importance here is that even though FF required no external finance (domestic or foreign) for its purchase of capital goods, the national income accounts record a net increase in the US current account and thus a net increase in FF's country's capital account. That is, the national accounts record this transaction as if the USB financed FF's purchase because it is the decline in FB's account at USB that raises the difference for the latter between holdings of foreign assets and its foreign liabilities.

Example 6—The consumption goods firm issues a corporate bond to the HH **in order to purchase capital goods from the foreign firm**. The first transaction here is identical to the first transaction in Example 2. The second transaction is nearly the reverse of Example 5, with CF's purchase of fixed capital produced by FF settled among USB and FB via an increase in FB's deposits at USB ($+D_{FB}$). This example presents domestic investment spending financed domestically. However, the national income accounts record a capital inflow as FB's acquires deposits at USB with no change in foreign-held liabilities of FB or FF.

Through the lens of Equation (1), both Examples 5 and 6 appear as increases in capital mobility to finance investment, the former as US capital outflows to FF, and the latter as the opposite. The reality is that both were financed domestically, with Example 5 being FF financing its own purchase.

Example 7—The HH purchases the foreign firm's commercial paper, issued to finance a purchase from the capital goods firm HH's purchase of FF's corporate bond debits the former's deposits at USB and credits FB's account (also at USB), which credits FF's deposits (FB's liability, likely in domestic currency).

[9] Borio and Disyatat (2010) also make this point.

[10] The caveat here is if FB's loan payment contains within it an interest payment because the latter would reduce FB's saving and raise For Bank's saving, ceteris paribus.

Here, again, it is only FF's imports from KF (the bottom transaction) that is a net financial flow across borders in national income accounts. The true financing of FF's import purchase is not a net financial flow, illustrating again how the capital mobility at the FHP's core is not recorded in the data FH and others used to estimate Equation (1). As noted above, data specifically linking gross capital flows to primary market purchases of securities for the specific purpose of fixed capital spending—rather than refinancing previous debts, for instance—simply do not exist, but these are the data that would be necessary to test the FHP.

Together, the examples show that determining whether capital is mobile (as in Examples 3, 4, and 7) and whether mobile capital actually finances fixed capital purchases (as in Examples 3, 5, 6, and 7) requires gross capital flow data at a level of detail that does not exist in national accounts data. Meanwhile, the saving and net capital flows in the capital account balance data from the national income accounting identity in Equation (2) that is the underlying estimation of Equation (1) by Feldstein and Horioka, and the FHP literature in general, get the source of finance wrong, repeatedly:

- Example 3 presents gross domestic investment financed by mobile capital, yet the national income accounts record it as a rise in domestic saving; that is, the national income accounts cannot distinguish Example 3 from Example 2 (gross domestic investment financed domestically), a point whose significance cannot be overstated here given that the purpose of estimating Equation (1) is to make this exact distinction;
- Example 5 presents a foreign firm financing its own capital goods purchase, yet the national income accounts record it as a rise in the capital account, not saving, of the foreign firm's country because the capital goods were imports; in other words, the national income accounts cannot distinguish this example from Example 7, which is the same capital goods import by FF instead financed by US investors;
- Example 6 presents a domestic investor financing imported capital goods financed by a domestic firm, which the national income accounts record as a rise in imports financed by international capital, and thus a rise in the capital account; to the national income accounts, domestic finance of imports in Example 6 is identical to both the self-financed purchase of imported capital goods in Example 5 and foreign finance of imports as in Example 7 (with the countries reversed).

As noted in the previous section, Ford and Horioka (2017) recognized the problems inherent in the depiction of international capital flows within Equation (1). Using multiple anecdotal examples, they argued that frictions in the international trade of goods and services, rather than barriers to international capital mobility, explain the FHP. This concurs with earlier research by Obstfeld and Rogoff (2001) and Eaton et al. (2016), all of whom argued that the true solution to the FHP is a "real" one. As Ford and Horioka (2017) put it, rapid net transfers of financial capital between countries require the absence of frictions in goods markets (p. 95).

Although technically true, this "real" solution is tautological: if the FHP appears to arise from rigidities in goods and services trade, it is because goods and services transactions (and international income transfers in the current account balance) are the only recorded transactions underlying estimation of Equation (1). As a general matter of accounting illustrated in Example 4 as well as in the first transactions for Examples 2, 3, 6, and 7, national income accounts do not record financing transactions as changes to saving or the capital account balance. The "real" solution envisions scenarios in which international capital mobility becomes more directly connected to trade. However, as demonstrated, the national income accounts by design do not record where financing originated and are thus unable to differentiate Examples 2 versus 3, Examples 5 versus 6, Examples 6 versus 7, and Examples 5 versus 7. Freeing international trade might change the current account balances of some or even many nations, but the accounting record of this is unrelated to the relative size of domestic versus international financing of a nation's investment spending.

The following section takes the next logical step and considers what regressions on Equation (1) actually do if they are not a test of the Feldstein–Horioka hypothesis.

4 | RATIONALIZING THE ECONOMETRIC ESTIMATES OF THE FELDSTEIN–HORIOKA REGRESSION

The literature reviewed in Section 2.1 showed that a large majority of the papers published are concerned with the size of the saving-retention coefficient, and that no agreement has been reached. Section 3 shows that the saving and investment series in the national accounts are inappropriate to test the Feldstein and Horioka hypothesis.

To complete our assessment, this section argues that Equation (1) cannot be used to test the hypothesis because saving and investment in the national accounts are related in such a way that regression (1) is a problematic exercise. We show that it is not a matter of estimation technique. We will argue that regression (1) is not a model in the sense that this term is used in econometrics, that is, an Equation that contains an error term that is a random variable. The consequence is that simple reasoning leads to the result that β^* must take on a value between 0 and 1 in most cases (whether it is close to 0 or to 1 is irrelevant), just as most of the literature has found. The surprise would have been to find otherwise, as we demonstrate below.

The OLS estimator of β^* in Equation (1) (β^*_{OLS}) is as follows:

$$\beta^*_{OLS} = \frac{\mathrm{Cov}\,(I_t, S_t)}{\mathrm{Var}\,(S_t)} \tag{3}$$

As noted above, the national accounts give the identity of Equation (2). Suppose a researcher estimated the regression:

$$I_t = \alpha + \beta S_t + \gamma KA_t + \varepsilon_t \tag{4}$$

where ε is the error term. It should be self-evident that the error term (ε) in Equation (4) is zero for every observation and that (estimated) $\alpha = 0$, $\beta = \gamma = 1$, and $R^2 = 1$. Consequently, adding to the earlier discussion about the inappropriateness of the series used to test the Feldstein–Horioka hypothesis, the accounting identity (2) poses a problem for the estimation and interpretation of β^* in Equation (1) as routinely done in the FHP literature. This is that the series involved in the discussion of the Feldstein–Horioka hypothesis and puzzle are related through the accounting identity (2). This implies that the error term u_t in Equation (1) is the capital account (KA_t), not an unknown random term. To be precise, the error in Equation (1) for each observation ($\hat{u}$) is (from identity (2) and the estimates of Equation (1), the latter denoted by ^) is as follows:

$$\hat{u}_t = I_t - \hat{I}_t = KA_t - \left[\hat{\alpha}^* + \left(\hat{\beta}^* - 1\right) S_t\right] \tag{5}$$

Equation (5) implies that

1. if $KA_t = 0$, then the identity is $I_t = S_t$, and then the estimation of Equation (1) will yield $\hat{\alpha}^* = 0$ and $\hat{\beta}^* = 1$ and actual residuals $\hat{u}_t = 0$ (perfect fit);
2. if $KA_t = KA$ (constant), the identity becomes $I_t = S_t + KA$, and the estimation of Equation (1) will yield $\hat{\alpha}^* = KA$, $\hat{\beta}^* = 1$, and $\hat{u}_t = 0$ (perfect fit);
3. if $S_t = 0$, therefore the identity is $I_t = KA_t$, then $\hat{\alpha}^* = \overline{KA}$ (where $\overline{KA}$ is the average value of KA_t) and $\hat{\beta}^* = 0$. Now, $\hat{u}_t = I_t - \hat{\alpha}^* = I_t - \overline{KA}$ (the fit of the regressions will be zero); and
4. if $S_t = S$ (constant), then the identity is $I_t = S + KA_t$, and $\hat{\alpha}^* = S + \overline{KA}$, and $\hat{\beta}^* = 0$. In this case, $\hat{u}_t = I_t - \hat{\alpha}^* = I_t - (S + \overline{KA})$ (the fit of the regression will be zero).

We stress that these results follow because the three series are related through the accounting identity. Moreover, they do not require estimating regression (1).[11]

The discussion above also implies that regression (1) can be interpreted as Equation (4) but with the former incurring omitted-variable bias for excluding KA_t, which in general is neither constant nor zero (and neither is S_t). The interpretation of the OLS estimate of $\hat{\beta}^*$ in (1) is, therefore, that it is a biased estimate of the 'true' slope parameter β in Equation (4).

This can be elaborated upon as follows. Algebraically, the expected value of β^*_{OLS} is as follows:

$$E\left(\beta^*_{OLS}\right) = \beta + \gamma \frac{\mathrm{Cov}\left(KA_t, S_t\right)}{\mathrm{Var}\left(S_t\right)} \tag{6}$$

where the "bias" due to the omission of KA_t in Equation (1) is $\gamma \frac{\mathrm{Cov}(KA_t, S_t)}{\mathrm{Var}(S_t)}$. However, because we know exactly what the omitted variable is, this is not the standard econometric problem, where there is an omitted but unknown variable (hence there is a true bias and, consequently, it makes sense to devise an econometric strategy to deal with it). For this reason, we refer to it as a pseudo bias, that is, $\textit{Pseudo Bias} = \gamma \frac{\mathrm{Cov}(KA_t, S_t)}{\mathrm{Var}(S_t)}$. Moreover, because $\beta = \gamma = 1$ in Equation (6) (from Equation (4)), then $\textit{Pseudo Bias} = \frac{\mathrm{Cov}(KA_t, S_t)}{\mathrm{Var}(S_t)}$, and we then have

$$E\left(\beta^*_{OLS}\right) = 1 + \frac{\mathrm{Cov}\left(KA_t, S_t\right)}{\mathrm{Var}\left(S_t\right)} = 1 + \textit{Pseudo Bias} \tag{7}$$

Naturally, $\textit{Pseudo Bias} = \frac{\mathrm{Cov}(KA_t, S_t)}{\mathrm{Var}(S_t)}$ is the coefficient b in the auxiliary regression $KA_t = c + bS_t$. All this should have been known to the researchers dealing with the puzzle if they had understood the nature of regression (1), given by the accounting identity in Equation (2).

It is self-evident that, given Equation (7), the following can be said about the expected value of β^*_{OLS}:

$$E\left(\beta^*_{OLS}\right) = 1 \;\; (\textit{Pseudo Bias} = 0) \;\; \text{iff } \mathrm{Cov}\left(KA_t, S_t\right) = 0, \text{or } \left|\mathrm{Cov}\left(KA_t, S_t\right)\right| \ll \mathrm{Var}\left(S_t\right) \tag{8a}$$

[11] Holmes and Otero (2014), for example, estimated three separate regressions (variables as percent of GDP): (i) investment on saving; (ii) current account on investment; and (iii) current account on saving. At no point did they authors acknowledge identity (2) or Equation (4), and the relation among the estimated coefficients.

$$E\left(\beta_{OLS}^{*}\right)=0\ \ (Pseudo\ Bias=-1)\ \text{ iff Cov}\left(KA_t,S_t\right)<0 \text{ and } \left|\text{Cov}\left(KA_t,S_t\right)\right|=\text{Var}\left(S_t\right) \quad (8b)$$

$$E\left(\beta_{OLS}^{*}\right)>1\ \ (Pseudo\ Bias>0)\ \text{ iff Cov}\left(KA_t,S_t\right)>0 \quad (8c)$$

$$E\left(\beta_{OLS}^{*}\right)<0\,(Pseudo\ Bias<-1)\ \text{ iff Cov}\left(KA_t,S_t\right)<0 \text{ and } \left|\text{Cov}\left(KA_t,S_t\right)\right|>\text{Var}\left(S_t\right) \quad (8d)$$

$$0<E\left(\beta_{OLS}^{*}\right)<1\,(Pseudo\ Bias<0)\ \text{ iff Cov}\left(KA_t,S_t\right)<0 \text{ and } \left|\text{Cov}\left(KA_t,S_t\right)\right|<\text{Var}\left(S_t\right) \quad (8e)$$

Cases (8a) and (8b) correspond to the logical extremes of the Feldstein–Horioka thesis that β^* should be close to zero (though not necessarily zero) and certainly below one. Our argument is that once the identity in Equation (2) (or Equation (4) in regression form) is recognized, it is self-evident that the coefficient β^* in Equation (1) must be less than 1 in most cases. The reason is that, in most countries, $b=\frac{\text{Cov}(KA_t,S_t)}{\text{Var}(S_t)}<0$, a result that follows from the fact that $\text{Cov}(KA_t,S_t)<0$. Researchers who have worked with the three variables I_t, S_t, and KA_t, know that the latter two variables are negatively correlated. This explains why the most likely outcome will be (8e).

Certainly, it is possible to find individual country cases that fit case (8b), that is, $\hat{\beta}^*=0$, but this requires $|\text{Cov}(KA_t,S_t)|=\text{Var}(S_t)$. Likewise, there could be countries that fit case (8c), that is, $\hat{\beta}^*>1$, which requires $\text{Cov}(KA_t,S_t)>0$, though we expect to find only a few such cases. Case (8d), $\beta^*<0$ is a result difficult to explain in the context of the Feldstein–Horioka hypothesis. For this to happen, $|\text{Cov}(KA_t,S_t)|>\text{Var}(S_t)$. Our argument remains that, whatever result regression (1) yields, it is the outcome of estimating a "quasi accounting identity" that does not test what the authors intend.

Some may argue at this point that all the above is known and implicit in the FHP literature. Although it is true that discussions in the FHP literature, and by Feldstein–Horioka originally, have referred to the three series in the identity, nobody has stated openly the obvious—that the series in regression (1) are related through an accounting identity with one missing variable—known to the researcher. We find it somewhat puzzling that Feldstein and Horioka themselves acknowledged the identity of Equation (2) multiple times. First, they noted that "the excess of gross domestic investment over gross domestic saving is equal to the net inflow of foreign investment [i.e., the capital account]" (Feldstein & Horioka, 1980, p. 320). Moreover, "the identity of *national* saving and investment does not imply equality of *domestic* saving and investment. Because of international capital flows, domestic saving and investment can differ for very long periods of time" (Feldstein & Horioka, 1980, p. 320; emphasis in the original).[12] Despite these statements, they did not seem to realize what this meant for their regression and for their interpretation of it.

Continuing with Feldstein and Horioka's exposition, they remarked that "a regression" of net foreign investment inflow to GDP on the domestic savings [sic] ratio would have a coefficient of β^*-1 " (Feldstein & Horioka, 1980, p. 320; using our notation for the estimated coefficient β^*). However, their (β^*-1) is, naturally, $b=\frac{\text{Cov}(KA_t,S_t)}{\text{Var}(S_t)}$ in the auxiliary regression above, what we labeled the pseudo bias in Equation (7) derived from the identity. Therefore, their summation

[12] The accounting identity is also explicit in Obstfeld and Rogoff's (2001, p. 350) statement: "[FH regression] summarizes in a compact way the fact that OECD current accounts tend to be surprisingly small relative to total saving and investment, especially when one averages over any sustained period."

that "Testing the hypothesis that β equals one is therefore equivalent to testing the hypothesis that the international capital flows do not depend on domestic savings [sic] rates" (Feldstein & Horioka, 1980, p. 320) is tautological precisely because the capital account is the omitted variable (but known to the researcher) in their regression.

Feldstein and Horioka also wondered whether "the high coefficient in the relation between domestic investment and domestic saving may reflect the impact of some third variable" (Feldstein & Horioka, 1980, p. 322). From Equation (2), this is obviously true. However, Feldstein and Horioka hypothesized that this variable could be, for instance, population growth or openness (exports plus imports over GDP). Neither variable worked (both were statistically insignificant). In this vein, Taylor (1994) argued that the standard Feldstein–Horioka high correlation between investment and saving is simply an artifact of omitted-variable bias. The high correlation between the two variables disappeared once the regression controlled for growth and demographics. However, we know that the missing variable is KA_t. This means that if an additional variable X_t "works" when added to Equation (1), it is because it is correlated with KA_t. This means that the higher the correlation between KA_t and X_t, the closer the coefficients of both the saving rate and of X_t will be to 1 (and the closer the regression fit to 1). This contrasts with Feldstein and Horioka's various regressions adding a third variable, the intent of which was clearly to find a missing variable that reduced the coefficient of X_t. Population growth and openness are not correlated with KA_t in a large cross section of countries. This again is suggestive of not recognizing that the identity in Equation (2) lies at the core of all their regressions.[13] We will return to this point in Section 5.

Finally, some authors have argued that the OLS estimates of Equation (1) are probably biased as a result of the endogeneity of the saving rate and proposed to use IV estimation methods. Yet, it is not clear that this route has solved the conundrum as IV estimates are still relatively high (e.g., Feldstein & Horioka, 1980).

As noted above, a significant portion of the literature has focused on estimation issues such as the existence of a dynamic relationship between savings and investment, the possible cointegration between the series, and the estimation of error correction models. None of these matters and none of them will solve the conundrum at hand. It should be obvious by now that the estimation of Equation (1) as an error correction model (e.g., Nell & Santos, 2008; Sinha & Sinha, 2004; Westerlund, 2006) does not solve the problem discussed. Although it is true that an error correction model can deal with the problem of unit roots in the investment and saving series (as shares of GDP), assuming these are present, and the estimate of β^* would be different from that in Equation (1), this is not the problem at hand (and recall the discussion in the previous section about the nature of the series used).[14]

[13] Given the accounting identity, the exercise could equally be run with the capital account as right-hand side variable, that is, $I_t = \alpha' + \beta' KA_t + \varepsilon_t$. The coefficients β^* in regression (1) and β' in this one are related as follows: $\beta^* = 1 + \frac{(\beta'-1)\mathrm{Var}(KA_t)}{\mathrm{Var}(S_t)}$. If, for example, $\beta^* = 0$, then $\beta' = 1 - \frac{\mathrm{Var}(S_t)}{\mathrm{Var}(KA_t)}$.

[14] To see this, note first that equation (identity) (4) in error-correction form can be estimated, assuming an autoregressive distributive lag, as $\Delta I_t = \alpha_1 \Delta I_{t-1} + \alpha_2 \Delta S_t + \alpha_3 \Delta S_{t-1} + \alpha_4 \Delta KA_t + \alpha_5 \Delta K_{t-1} + \lambda_1 I_{t-1} + \lambda_2 S_{t-1} + \lambda_3 KA_{t-1}$ (again, no error term). It is obvious that the coefficients α_2 (ΔS_t) and α_4 (ΔKA_t) will be 1, those of all other variables will be 0, and the regression will yield a perfect fit. This can be corroborated. The error correction model corresponding to Equation (1) is $\Delta I_t = \alpha^* + \gamma_1 \Delta I_{t-1} + \gamma_2 \Delta S_t + \gamma_3 \Delta S_{t-1} + \delta_1 I_{t-1} + \delta_2 S_{t-1} + \varepsilon_t$. The "long-run elasticity" of investment with respect to the saving rate in this representation is calculated as: $\theta^* = -(\frac{\delta_2}{\delta_1})$. Yet, we return to the same discussion as above about the pseudo bias in the coefficient of the saving rate. Estimating an error correction model is not the solution.

Summing up, none of these arguments requires regression analysis, just simple reasoning. There is no econometric issue to solve (e.g., endogeneity of the saving rate) or the existence of an adjustment process to equilibrium that requires specific econometric techniques.

5 | EMPIRICS: WHAT DOES THE FELDSTEIN–HORIOKA REGRESSION TELL US?

We are now in a position to consider what regression Equation (1) actually does if it is not a test of the Feldstein–Horioka hypothesis. To document our arguments, we obtained consistent data to construct the identity $I_t \equiv S_t + KA_t$ for a sample of 70 countries for 1960–2019, and estimated regression (1).[15] The discussion below is based on our interpretation that β^* is, by definition, $1 + \frac{\mathrm{Cov}(KA_t, S_t)}{\mathrm{Var}(S_t)}$, a result that was derived from the fact that the accounting identity Equation (2) (Equation (4) in regression form) is the "true" model where $\beta = 1$.

Feldstein and Horioka (1980) argued that β^* should be close to zero (though not necessarily zero) and certainly below one. The discussion about the possible values of β^* in Section 4 was not based on statistical estimation. When this is done, then the coefficient will have a confidence interval. We estimated Equation (1) and divided countries into four groups according to the size and statistical significance of the estimated β^*: (a) those with $\hat{\beta}^* = 0$; (b) those with $0 < \hat{\beta}^* < 1$ (split between countries with $0 < \hat{\beta}^* < 0.5$ and countries with $0.5 < \hat{\beta}^* < 1$); (c) those with $\hat{\beta}^* \geq 1$; and (d) those with $\hat{\beta}^* < 0$. Cases (a) and (b) would be interpreted in the literature as evidence that there is capital mobility (the smaller $\hat{\beta}^*$ the higher the degree of mobility), that is, that world capital markets are relatively integrated. Case (c) would be interpreted as evidence of low or no capital mobility.

Estimation results are shown in Tables 2 and 3. They provide the estimates of β^*, the numerator and denominator of the pseudo bias, and the 95% confidence interval. Table 2, Panel A, shows the pooled regressions. Panel B shows the individual-country regressions where $\hat{\beta}^* = 0$. Panel C shows the countries where $0 < \hat{\beta}^* < 1$ (the latter arbitrarily split between those countries where $0 < \hat{\beta}^* < 0.5$ (panel C.1), and those countries where $0.5 < \hat{\beta}^* < 1$ (panel C.2)). Table 3 provides the country results for the cases where $\hat{\beta}^* \geq 1$ (panel A) and $\hat{\beta}^* < 0$ (panel B). As indicated in the discussion above, $\mathrm{Cov}(KA_t, S_t) < 0$ in column (2) in all cases except for Nepal and Slovenia. For these two, the *Pseudo Bias* is positive (case (8c) above).

We highlight the following results for β^*: (a) the coefficients of the five pooled regressions are positive and oscillate between 0.36 and 0.39 for the first three larger samples (all, OECD, developing), and 0.64–0.68 for the Feldstein–Horioka sample (pooled data, and averaging per country as in Feldstein–Horioka), all statistically different from zero and smaller than 1; (b) there are 18 country cases where $\hat{\beta}^* = 0$ and 19 where $0 < \hat{\beta}^* < 0.5$ (i.e., relatively small values). Probably the literature would interpret all these 37 as corroboration (non-rejection) of the Feldstein–Horioka null hypothesis; (c) there are 14 cases where $0.5 < \hat{\beta}^* < 1$ (i.e., relatively high values but all smaller than 1) and 13 cases where $\hat{\beta}^* \geq 1$ (the null hypothesis that $\hat{\beta}^*$ is statistically greater than 1 cannot be rejected in two cases, Nepal and Slovenia, indicating that they export capital). The literature

[15] The data source is the Penn World Table (version 10.0). Other papers testing the FHP (e.g., Adedeji & Thornton, 2008; Sinha & Sinha, 2004) have also used data from the Penn World Tables.

TABLE 2 Feldstein–Horioka regressions I.

Country	$\mathrm{Cov}(KA_t, S_t)$ (2)	$\mathrm{Var}(S_t)$ (3)	$b =$ *Pseudo Bias* $= \frac{\mathrm{Cov}(KA_t,S_t)}{\mathrm{Var}(S_t)}$ (4)	$\hat{\beta}^* = 1 +$ *Pseudo Bias* (5)	95% confidence interval for $\hat{\beta}^*$ (6)
A. Pooled regressions					
All countries (1960–2019)	−0.015174	0.024824	−0.6113	0.3887***	0.3718, 0.4057
OECD (1960–2019)	−0.005527	0.008619	−0.6412	0.3588***	0.3306, 0.3869
Developing economies (1960–2019)	−0.019253	0.031924	−0.6031	0.3969***	0.3743, 0.4195
FH countries (1960–1974) pooled data	−0.0020	0.0057	−0.3584	0.6416***	0.5720, 0.7113
FH countries (1960–1974) averaged	−0.0017	0.0052	−0.3199	0.6801***	0.4383, 0.9218
B. Countries where $\hat{\beta}^* = 0$: very high degree of capital mobility in the FH terminology					
Belgium	−0.0010	0.0012	−0.8358	0.1643	−0.0636, 0.3923
Colombia	−0.0009	0.0009	−0.9994	0.0006	−0.2887, 0.2900
Denmark	−0.0029	0.0029	−1.0180	−0.0180	−0.1315, 0.0954
China, Hong Kong SAR	−0.0069	0.0074	−0.9428	0.0572	−.00932, 0.2075
Iran	−0.0095	0.0108	−0.8788	0.1212	−0.0072, 0.2497
Luxembourg	−0.0163	0.0176	−0.9229	0.0771	−0.0301, 0.1842
Netherlands	−0.0009	0.0009	−1.0404	−0.0404	−0.3720, 0.2912
New Zealand	−0.0003	0.0004	−0.7830	0.2170	−0.1419, 0.5758
Singapore	−0.0585	0.0590	−0.9904	0.0096	−0.1174,0.1367
Switzerland	−0.0019	0.0014	−1.2969	−0.2969	−0.6349, 0.0411
Aruba	−0.0189	0.0217	−0.8947	0.1053	−0.0226, 0.2332
Bahrain	−0.0160	0.0129	−1.2435	−0.2435	−0.5557, 0.0687
Bulgaria	−0.0017	0.0020	−0.8307	0.1693	−0.2443, 0.5829
Philippines	−0.0009	0.0009	−0.9605	0.0395	−0.2220, 0.2584
Saudi Arabia	−0.0193	0.0218	−0.8858	0.1142	−0.0194, 0.2478
Azerbaijan	−0.0342	0.0311	−1.1008	−0.1008	−0.3058, 0.1043
Belarus	−0.0015	0.0019	−0.8256	0.1744	−0.1134, 0.4622
Slovakia	−0.0003	0.0004	−0.7870	0.2130	−0.4631, 0.8891
C. Countries where $0 < \hat{\beta}^* < 1$: some degree of capital mobility in the FH terminology					
C.1 Cases where $0 < \hat{\beta}^* < 0.5$					
Albania	−0.0065	0.0112	−0.5796	0.4205***	0.2514, 0.5896
Algeria	−0.0041	0.0073	−0.5646	0.4354***	0.2374, 0.6334
Angola	−0.0083	0.0141	−0.5917	0.4083**	0.1163, 0.7003
Argentina	−0.0007	0.0009	−0.7703	0.2297*	0.2297, 0.1106
Canada	−0.0004	0.0005	−0.7469	0.2531*	0.0579, 0.4483
Cayman Islands	−0.0016	0.0022	−0.7462	0.2538**	0.0844, 0.4233

(Continues)

TABLE 2 (Continued)

Country	$\mathrm{Cov}(KA_t, S_t)$ (2)	$\mathrm{Var}(S_t)$ (3)	$b =$ *Pseudo Bias* $= \frac{\mathrm{Cov}(KA_t,S_t)}{\mathrm{Var}(S_t)}$ (4)	$\hat{\beta}^* = 1 +$ *Pseudo Bias* (5)	95% confidence interval for $\hat{\beta}^*$ (6)
Costa Rica	−0.0028	0.0049	−0.5783	0.4217***	0.3283, 0.5152
Egypt	−0.0036	0.0057	−0.6210	0.3790***	0.3080, 0.4500
Indonesia	−0.0018	0.0031	−0.5979	0.4021*	0.0045, 0.7998
Ireland	−0.0308	0.0386	−0.7989	0.2011***	0.1217, 0.2805
Italy	−0.0002	0.0005	−0.5153	0.4847***	0.2696, 0.6998
Kenya	−0.0008	0.0011	−0.7003	0.2997*	0.0134, 0.5859
Mexico	−0.0003	0.0004	−0.6847	0.3153*	0.0354, 0.5953
Pakistan	−0.0007	0.0009	−0.7139	0.2861***	0.1788, 0.3933
Panama	−0.0075	0.0111	−0.6749	0.3251***	0.1549, 0.4952
United Kingdom	−0.0008	0.0011	−0.7698	0.2302*	0.0546, 0.4059
United States	−0.0004	0.0007	−0.5762	0.4238***	0.2798, 0.5677
Venezuela	−0.0264	0.0358	−0.7361	0.2639***	0.1341, 0.3936
United Arab Emirates	−0.0107	0.0187	−0.5700	0.4300***	0.2776, 0.5823
C.2 Cases where $0.5 < \hat{\beta}^* < 1$					
Austria	−0.0004	0.0018	−0.2230	0.7770***	0.6149, 0.9392
Bangladesh	−0.0019	0.0101	−0.1902	0.8098***	0.7534, 0.8661
Chile	−0.0050	0.0103	−0.4796	0.5204***	0.4331, 0.6077
Cyprus	−0.0061	0.0221	−0.2758	0.7242***	0.6062, 0.8422
Finland	−0.0013	0.0030	−0.4372	0.5628***	0.3127, 0.8129
Germany	−0.0006	0.0017	−0.3704	0.6296***	0.2742, 0.9850
Greece	−0.0016	0.0084	−0.1863	0.8137***	0.7151, 0.9122
India	−0.0020	0.0074	−0.2721	0.7279***	0.6788, 0.7770
Malaysia	−0.0017	0.0060	−0.2853	0.7147***	0.5240, 0.9055
Peru	−0.0017	0.0047	−0.3528	0.6472***	0.5658, 0.7286
Republic of Korea	−0.0036	0.0123	−0.2933	0.7067***	0.6304, 0.7830
South Africa	−0.0013	0.0028	−0.4592	0.5408***	0.3858, 0.6958
Taiwan	−0.0019	0.0050	−0.3711	0.6289***	0.5063, 0.7515
Turkey	−0.0009	0.0028	−0.3081	0.6919***	0.5110, 0.8728

*Denotes statistical significance at the 95% level, ** 99% level, and *** 99.9% level.
Source: Authors.

would probably interpret these 27 cases as a rejection of the Feldstein–Horioka null hypothesis; and (d) there are six cases with $\hat{\beta}^*$ <0, which result from a very large negative *Pseudo Bias*.[16]

[16] Differences in the magnitude of β^* for the 70 countries are the result of differences in both $Cov(KA_t, S_t)$ in the numerator of the *Pseudo Bias* and $Var(S_t)$ in the denominator, as the variances of both are not statistically different (the ratio of the two variances under the null that they are equal, follows an F-distribution).

TABLE 3 Feldstein–Horioka regressions II.

Country	$Cov(KA_t, S_t)$ (2)	$Var(S_t)$ (3)	$b = Pseudo\ Bias = \frac{Cov(KA_t,S_t)}{Var(S_t)}$ (4)	$\hat{\beta}^* = 1 + Pseudo\ Bias$ (5)	95% confidence interval for $\hat{\beta}^*$ (6)
A. Countries where $\hat{\beta}^* \geq 1$: low degree of capital mobility in the FH terminology					
Australia	−0.0001	0.0004	−0.1534	0.8466***	0.5300, 1.1632
Bhutan	−0.0007	0.0024	−0.2866	0.7134***	0.3687, 1.0580
Brazil	−0.0001	0.0007	−0.1985	0.8015***	0.5718, 1.0311
China	−0.0005	0.0112	−0.0455	0.9545***	0.9041, 1.00049
France	−0.0001	0.0007	−0.1272	0.8728***	0.6963, 1.0493
Japan	−0.0004	0.0029	−0.1262	0.8738***	0.7415, 1.0060
Morocco	−0.0010	0.0101	−0.0989	0.9011***	0.7758, 1.0265
Nepal	0.0002	0.0066	0.0341	1.0341***	0.8759, 1.1923
Nigeria	−0.0059	0.0596	−0.0986	0.9014***	0.7955, 1.0073
Slovenia	0.0002	0.0005	0.3966	1.3966***	0.6958, 2.0975
Spain	−0.0001	0.0005	−0.1422	0.8578***	0.5121, 1.2035
Thailand	−0.0006	0.0044	−0.1396	0.8604***	0.7141, 1.0067
Russian Federation	−0.0005	0.0048	−0.0934	0.9066***	0.7531, 1.0600
B. Countries where $\hat{\beta}^* < 0$					
Antigua and Barbuda	−0.0568	0.0501	−1.1342	−0.1342*	−0.2578. −0.0106
Bahamas	−0.0117	0.0069	−1.6839	−0.6839***	−1.0103, −0.3575
Belize	−0.0090	0.0078	−1.1559	−0.1559**	−0.2652, −0.0466
Brunei Darussalam	−0.0126	0.00743	−1.6884	−0.6884***	−1.0110, −0.3658
Norway	−0.0226	0.0150	−1.5067	-0.5067***	−0.5943, −.4191
Sweden	−0.0018	0.0012	−1.4793	−0.4793***	−0.7051, −0.2535

*Denotes statistical significance at the 95% level, ** 99% level, and *** 99.9% level.
Source: Authors.

5.1 | The additional missing variable: "Where is Waldo?"[17]

We can now illustrate our points in Section 4 regarding Feldstein and Horioka's search for a missing variable using some examples (from Table 2). Consider Equation (9), where β_S^* is the coefficient on saving, X_t is a "third" variable or a vector of several of them, with θ_X^* being the coefficient(s), and ξ is an error term:

$$I_t = \alpha^* + \beta_S^* S_t + \theta_X^* X_t + \xi_t \tag{9}$$

We argued above, commenting on the Feldstein–Horioka results, that if any added variable to regression (1) (e.g., population growth, openness) works econometrically, it is because it must be correlated with KA_t (the missing variable) in the cross section of countries. Moreover, when this

[17] *Where is Waldo?* is an old children's game where Waldo, a little guy wearing a red-and-white-striped shirt, bobble hat, and glasses is hidden. The purpose of the game was to find the character. It was created by British children's book illustrator Martin Hanford in 1987 under the original title *Where is Wally?*

TABLE 4 Estimation results of Equation (9).

			θ_X^*, where X_t is:						
	$\hat{\alpha}^*$	$\hat{\beta}_S^*$	Pop	$Openess$	$\frac{b_0+b_1t}{1+b_2t+b_3t^2}$	$\frac{\cos(t^{0.6})}{25}$	$\frac{\sin(\frac{t-1}{9})}{10}$	$\frac{\sin((0.9t)^{0.75})}{13}$	Adj. R^2
Country	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
United States 1960–2019	0.15***	0.42***							0.36
	−0.05	0.92***	0.35***						0.52
	0.01	0.88***		0.21***					0.57
	0.01	0.97***			0.93***				0.67
Canada 1960–2019	0.18***	0.25**							0.10
	0.18***	0.23**	0.05						0.10
	0.19***	0.19*		0.02					0.10
	0.19***	0.22**							0.10
	0.16***	0.35***				0.34***			0.32
Denmark 1960–2019	0.27***	−0.02							−0.02
	0.24***	−0.05	0.69						−0.03
	0.26***	0.13		−0.04*					0.03
	0.26***	0.03							−0.03
	0.15***	0.41***					0.41***		0.46
Philippines 1970–2019	0.18***	0.04							−0.02
	0.18***	0.04	−0.001						−0.04
	0.13***	0.20		0.09					0.01
	0.19***	−0.01							−0.04
	0.02***	0.23***						0.39***	0.49

*Denotes statistical significance at the 95% level, ** 99% level, and *** 99.9% level.
Source: Authors.

happens, the coefficient on the saving rate must approximate one, not zero. Population growth and openness did not do the job in their case, the same as with our data set; that is, both variables are statistically insignificant because they cannot track the share of the capital account in GDP in the cross section of countries.

To see why this is the case, Table 4 presents individual-country results for the United States, Canada, Denmark, and the Philippines. The first row for each country shows the results from Table 2 (columns 1 and 2) for the United States and Canada (both with $0 < \hat{\beta}^* < 0.5$), and for Denmark and the Philippines (both with $\hat{\beta}^* = 0$). Coefficients (θ_X^*) for the variables (X_t) tested in separate regressions are in columns 3 through 8. Like Feldstein and Horioka, we also tested the role of population growth and openness ($Openness$, defined as the ratio of exports plus imports over GDP). Population growth is statistically insignificant in all four cases (not shown). As a variant, we used the level of population (Pop). The variables tested in columns 5–8 were created to prove our point that *any* variable that is minimally well correlated with KA should greatly improve the results but in a way contrary to the Feldstein and Horioka expectation.

For the United States, columns 3, 4, and 5 show Equation (9) estimated with three variants of X_t, namely, Pop, $Openness$, and $\frac{b_0+b_1t}{1+b_2t+b_3t^2}$ (a variable that we created. It is a function of time (t), derived by fitting a nonlinear regression function by least squares). In all three cases, the regression fit is significantly higher than that obtained in the regression with S_t alone in the top row

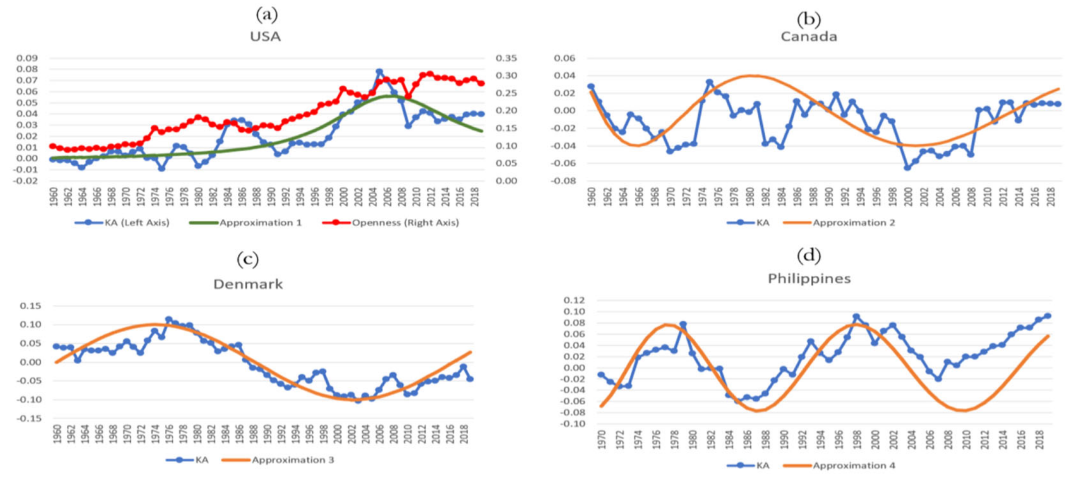

FIGURE 1 Figure 1(a) for the United States uses Approximation 1 and Openness; Figure 1(b) for Canada uses Approximation 2; Figure 1(c) for Denmark uses Approximation 3; Figure 1(d) for the Philippines uses Approximation 4.

Note: KA is the ratio of the capital account over GDP; $Openness$ is the ratio of exports plus imports over GDP; Pop is population in billions; $1 = \frac{b_0+b_1t}{1+b_2t+b_3t^2}$ Approximation $2 = \frac{\cos(t^{0.6})}{25}$; Approximation $3 = \frac{\sin(\frac{t-1}{9})}{10}$; Approximation $4 = \frac{\sin((0.9t)^{0.75})}{13}$.

Source: Authors.

[Colour figure can be viewed at wileyonlinelibrary.com]

(seen in a higher adjusted R^2 in column 9 relative to that in the top row). Note that the improved fit here results in much higher values of β_S^* (approximating 1, rather than β_S^* closer to zero) and the constant term (α^*) becomes statistically insignificant, consistent with the regression of the identity. In the cases of Canada, Denmark, and the Philippines, Pop and $Openness$ are insignificant. However, when we add to the respective regressions the variables that we created (see columns 6, 7, 8), the regressions improved significantly.

Figure 1 complements Table 4 by showing graphically the variables in columns 4–8 in Table 4. It helps explain why adding these variables the regression results improve. Panel (a) for the United States shows that both $Openness$ and $\frac{\boldsymbol{b}_0+\boldsymbol{b}_1\boldsymbol{t}}{1+\boldsymbol{b}_2\boldsymbol{t}+\boldsymbol{b}_3\boldsymbol{t}^2}$ are highly correlated with this country's KA. All three variables basically rise through time. By contrast, the coefficients for Pop, and $Openness$ for Canada, Denmark, and the Philippines in Table 4, are not statistically significant and do not improve the fit as measured by the adjusted R^2, versus the regressions in the top rows of the respective countries. Panels (b)–(d) in Figure 1 show why each of these countries' KAs behaves much differently from that of the United States. Because all three countries' KAs exhibit wave-like long-run patterns, we show how different trigonometric functions of time approximate them for each country (obviously, other approximations are possible). These trigonometric functions are the X_t variables in columns 6–8 of Table 4. As expected, each is statistically significant, raising the adjusted R^2 relative to those of the regressions in the first row for each country. More importantly, in each case, the estimated β_S^* increases relative to its value in the country's first row, and for both Denmark and the Philippines, it becomes statistically significant. Again, as above, every part of this is entirely expected when recognized that the identity in Equation (2) is what lies beneath regressions of Equation (1).

Overall, the foregoing discussion of Table 4 and the examples in Figure 1 illustrate that the search for "missing variables" to explain the results in Equation (1) in the FHP literature suggests a lack of recognition of the underlying identity Equation (2). Likewise, any estimated value of the coefficient β^* on S_t in Equation (1) that is not equal to 1 necessarily suggests this same lack of recognition.

6 | CONCLUSIONS

Does financial capital flow across countries? During the last decades, and as the world became increasingly globalized, international capital appeared to move easily. It seems that the obvious answer to the question would be yes. Yet, when Feldstein and Horioka (1980) formulated this question by way of a statistical hypothesis and tested it with saving and investment data from the national accounts, the answer was a puzzling no. Although some authors have provided empirical evidence to the contrary and have concluded that capital is mobile, the puzzle remains today. The literature on the topic is huge, the original question has been approached in many different ways, and authors have applied all kinds of statistical techniques to different groups of countries and time periods. All this effort has not led to an accepted answer by the profession.

This paper has proposed a nihilistic answer to the 40-year-old puzzle. We have argued that the Feldstein and Horioka paper started on the wrong foot. We have discussed two problems. First, we have shown that, since 1980, researchers have used conceptually wrong series to test the Feldstein and Horioka hypothesis. Unfortunately, the correct series are not collected currently. Seemingly counterintuitive results (a large coefficient on the saving rate) have kept the profession digging (through different techniques) further along this research program for four decades, without seeing the light.

Unfortunately, the data for the question that Equation (1) attempts to answer do not exist. Perhaps, and with the current data, the best economists can do is to follow Shin's (2012) example based on US Flow of Funds accounts and Bank for International Settlements banking statistics data. Shin showed that European banks held large amounts of US mortgage-backed securities and other structured claims on US borrowers in the 2000s; he then also confirmed that the US subsidiaries of those banks funded the purchases via borrowings in wholesale US funding markets and then "shipped" the funds to their home offices. Shin relied on gross flows, not the net flows recorded, as the current account and capital account balances because "to the extent that the banking sector plays an important role in influencing credit conditions, it is gross flows rather than net flows" that are relevant (Shin, 2012, p. 157). In contrast to the "savings glut" view (e.g., Bernanke, 2005), Shin showed that these European banks were not funding the US housing bubble with "excess savings" from Europe.

The closest approximation to the data needed would be cross-border changes to claims on businesses (debt and equity) and HH mortgages (mortgages and mortgage-backed securities because purchases of new homes are part of gross private domestic investment) for domestic private sectors and similar for government-issued liabilities. Even this is inadequate because (currently, at least) it does not account for primary versus secondary market purchases, financing of new homes versus "used" homes, and so forth. Such data would need to record flows for specific loans, securities, and other financial assets, all newly created or issued. This would still not be fully adequate, as, for example, newly created liabilities, refinance outstanding debt, finance equity repurchases, and so forth, rather than fixed capital spending. Shin (2012) noted similar data difficulties and added that "remedying the data gaps would be an important first step in shedding light on shifting global financial conditions" (p. 173).

Second, we have shown that regressions like Equation (1) miss the crucial point that, by adding the capital account on the right-hand side, they become an accounting identity, Equation (2). Consequently, we have argued that the Feldstein–Horioka regression is a quasi-accounting identity. The implication is that the finding in this regression of a coefficient of the saving rate between zero and one (with the precise value being an irrelevant issue) is a foregone result with not much economic interest. This conclusion, together with the fact that the saving and investment series in the national accounts are not the ones that should be used to test the Feldstein–Horioka hypothesis, casts doubt on the soundness and strength of one of the greatest puzzles in macroeconomics.

We end with two important corollaries. One is that using the results of the Feldstein–Horioka regression to derive policy implications (what governments should do) is problematic. The reason is that both saving and investment are endogenous and regression (1) cannot distinguish exogenous shifts in saving from endogenous shifts reflecting factors that also impact on investment. In any case, government actions that promote saving are likely to be part of packages that may also promote investment. Providing policy implications is even more debatable in the light of the critical arguments of this paper.

The other one is that the profession should seriously reconsider this research program (as discussed in this paper), focus on collecting the correct series, and think carefully about the testing strategy. Conducting further tests of the Feldstein and Horioka hypothesis is by now a futile effort with decreasing returns. We wonder what a correct test of the Feldstein–Horioka hypothesis would yield with data covering the globalization period. Since 2020, the COVID pandemic, the Russia–Ukraine war, and the increasing tensions between China and the United States have led many analysts to speak of a retreat of globalization. One would have to test if, after 2020, countries rely more on domestic savings, and international capital market integration has declined. This also implies reconsidering the theoretical rationale of the hypothesis, as discussed in Section 2.2, in particular the classical view that saving finances investment.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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APPENDIX: Decomposing the Capital Account

As our measure KA includes both the capital account and the statistical discrepancy, we can further illustrate the point about the pseudo bias. Denoting the "true" measure of the capital account by KA^* and the statistical discrepancy by SD (both as a percent of GDP), we have $KA \equiv KA^* + SD$, where SD is the negative of the officially reported statistical discrepancy.[1] Consequently, the pseudo bias in column (5) of Tables 2 and 3 is really the sum of the pseudo biases for KA^* and SD.

Table A1 presents the estimation results of equation (1) augmented with the additional regressor KA^* as in equation (A1) below:

$$I_t = \alpha^* + \beta_S^* S_t + \delta_{KA^*}^* KA_t^* + \epsilon_t \quad \text{(A1)}$$

As above in equation (5), the error of each observation is given by the difference between equation (4) with $\alpha = 0, \beta = \gamma = 1$ and the estimated equation (A1). That is, $\hat{e}_t = I_t - \hat{I}_t = SD_t - [\hat{\alpha}^* + (\hat{\beta}_S^* - 1)S_t + (\hat{\delta}_{KA^*}^* - 1)KA_t^*]$.

Certainly, adding KA_t^* as an additional regressor should improve the results. Indeed, the coefficient of the saving rate (β_S^*) in Table A1 starts moving in the direction determined by equation (4), that is, unity. In all cases except five, $0 < \hat{\beta}_S^* \leq 1$ and $\hat{\beta}_S^*$ is statistically different from zero (e.g., compare the coefficient of the saving rate for Norway in Table A1 to that in Table 3). In some cases, $\hat{\beta}_S^*$ is nearly 1 (e.g., Hong Kong, SAR, Denmark, and Belgium). The difference with respect to the complete identity in equation (2) is that equation (A1) omits the SD. This illustrates how the omission of KA in equation (1) causes a very large pseudo bias in the coefficient of the saving rate in these countries.

Table A1

Estimation results of Equation (A1)

Country	α^* (1)	β_S^* (2)	$\delta_{KA^*}^*$ (3)
Countries with $\beta^* < 0$ in Table 3			
1960-2019			
Norway	0.13***	0.52***	0.53***
Sweden	0.11**	0.16***	0.11***
1970-2019			
Antigua and Barbuda	0.05	0.33***	0.38***
Bahamas	0.08**	0.55***	0.80***
Belize	0.08***	0.20***	0.48***
Brunei-Darussalam	0.14*	0.55***	0.73***
Countries with $\beta^* = 0$ *(i.e., statistically insignificant)* in Table 2			
1960-2019			

[1] We use the variable "csh_r," which is the "share of residual trade and GDP statistical discrepancy at current purchasing power parities" from Penn World Table (version 10.0), as in the previous note. According to Feenstra et al. (2015), this statistical discrepancy is the difference between total expenditure C + I + G + X - M and total GDP. Depending on the country data, csh_r may have residual trade, which includes trade in services.

Belgium	0.03**	0.89***	0.97***
Colombia	**0.21*** **	**0.06**	**0.38**
Denmark	-0.02	0.97***	0.92***
China, Hong Kong, SAR	0.00	1.00***	1.00***
Iran	0.23***	0.17**	0.04
Luxembourg	0.12***	0.22***	0.40***
Netherlands	0.03	0.78***	0.69***
New Zealand	0.15***	0.33**	0.59***
Singapore	0.09***	0.56***	0.55***
Switzerland	-0.08***	1.11***	1.36***
1970-2019			
Aruba	-0.01*	1.08***	0.98***
Bahrain	0.14**	0.44***	0.48***
Bulgaria	**0.11*** **	**-0.20** **	**0.97*** **
Philippines	**0.14*** **	**0.07**	**0.87*** **
Saudi Arabia	0.12***	0.85***	0.84***
1990-2019			
Azerbaijan	**0.20*** **	**-0.20*** **	**-0.14**
Belarus	**0.15*** **	**0.11**	**0.22*** **
Slovakia	0.08**	0.62***	0.68***
Countries with $\beta^* > 1$ in Table 3			
1960-2019			
Nepal	0.06***	0.70***	0.74***
1990-2019			
Slovenia	-0.08**	1.20***	0.81***

Source: Authors.
Note: * denotes statistical significance at the 95 percent level, ** 99 percent level, and *** 99.9 percent level.

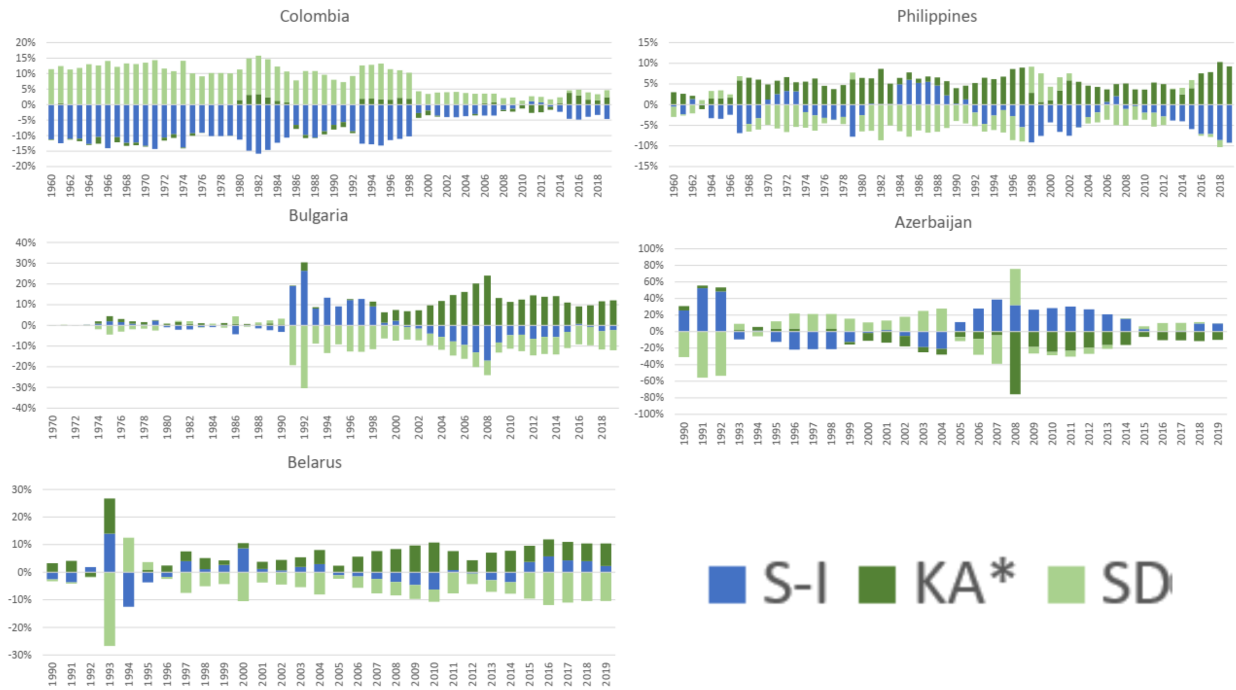
There are now only five cases where results are still rather poor (these are in bold in Table A1). All are cases for which $Bias_{SD}$ drives $Bias$: Colombia, Philippines, Bulgaria, Azerbaijan, and Belarus (the other two being Luxembourg and New Zealand; both now show $0 < \beta_S^* \leq 1$ in Table A1). Obviously, SD causes the large pseudo bias. If regression (A1) is instead estimated for these countries with SD and KA^*switching places, then, as expected, $0 < \beta_S^* \leq 1$. To better understand this, it is interesting to consider for these five cases the path of the relative sizes of S and I. For this, we rearrange the saving-investment identity: because $I \equiv S + KA^* + SD$, we therefore have:

$$(S - I) + (KA^* + SD) \equiv 0 \tag{A2}$$

Figure A1 shows $(S - I)$, KA^*And SD, for the five outlier countries in Table A1. For all five, it is clear that the very large SD values cause the estimated coefficients in Table A1 to deviate substantially from 1. We conjecture that in these cases, this reflects significant measurement problems.

Figure A1

Countries in Table A1 with Large SD



Source: Authors