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Taking Money Seriously and Putting it Back into the Feldstein-Horioka Saving-Investment Nexus

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Abstract

Theoretically based on national income accounting identities, the Feldstein-Horioka hypothesis downplays, if not totally ignores, the influence of monetary factors on international capital mobility. Recognizing the historical development of economics and the institutional arrangements of the exchange rate regime, this study extends the theoretical framework by integrating the balance of payments and national income accounting equations to show that domestic investment is related to not only domestic saving and international capital flows but also changes in the domestic money supply and credit creation. Panel data regression results for the original Feldstein-Horioka sample – 20 OECD countries over the years 1960 – 1974 – empirically support the theory. In contrast to the Feldstein-Horioka findings, a lower saving-investment coefficient is found, suggesting higher international capital mobility though still with some degree of home bias. Overall, this study illustrates the importance of money, history of economics and economic institutions in understanding and resolving the Feldstein-Horioka puzzle.

JEL Classifications: E2, E5, F3, F4

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I. Introduction

The Feldstein-Horioka puzzle is one of the six major puzzles in international macroeconomics (*Obstfeld* and *Rogoff* 2000). In *Feldstein* and *Horioka's* (1980) highly influential paper, their cross-sectional regression results indicate a strong

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positive correlation between domestic saving rate (as a ratio to GDP) and investment rate among 21 OECD countries for the period 1960–74. This finding is contrary to their postulation that domestic saving and domestic investment should not be highly correlated under a high degree of international capital mobility. This stylized finding remains robust for larger samples and also in subsequent years even though it has become noticeably weaker. This is both puzzling and disturbing as it is contradictory to many other studies indicating evidence of international capital mobility. Feldstein and Horioka attribute this finding to a strong home bias of domestic saving.

The proliferation of the literature on the Feldstein-Horioka puzzle has become so voluminous that it is probably not a right place to give an extensive literature review here. Excellent surveys of the related literature can be found in, for example, *Obstfeld* and *Rogoff* (1995, 1996, chapter 3 and 2000), *Coakley*, *Kulasi* and *Smith* (1998), *Belloc* and *Gandolfo* (2002), and *Apergis* and *Tsoumas* (2009). More recently, *Chu* (2012) extends *Gandolfo's* (2001) classifications and categorizes the various theoretical or empirical studies that attempt to resolve the puzzle into the following categories: (i) to resolve the puzzle from an econometric or empirical perspective, (ii) to examine if the puzzle also holds in country groups other than the OECD countries, (iii) to reexamine the puzzle empirically by redefining investment, (iv) to resolve the puzzle theoretically, and (v) to evaluate the appropriateness of the saving-investment correlation as a measurement of international capital mobility. On the other hand, Singh (2016) surveys and summarizes the empirical techniques and findings of the major studies starting from the original Feldstein and Horioka study to the latest studies published in 2015.

The aforementioned surveys reveal that the majority of studies trying to resolve the puzzle are empirical and that there is a fashionable trend of adopting more and more advanced econometric methods. The application of panel data econometrics, for example, to examine the puzzle is by no means novel (see e.g. *Corbin* 2004, among many others), and the trend of using panel cointegration methods and the related advanced empirical techniques continues, as evidenced by the recent empirical studies of *Kumar* et al. (2014), *Kumar* (2015), *Drakos* et al. (2017, 2018), *Chan* et al. (2018), *Pata* (2018), *Ginama* et al. (2018), *Ko* and *Funashima* (2019), *Eyuboglu* and *Uzar* (2020), *Camarero* et al. (2020), *Olayeni* et al. (2021), and *Yilanci* and *Kilci* (2021), to name just a few. However, the results of such sophisticated econometric studies remain at best mixed. In the words of *Obstfeld* and *Rogoff*, "… none of the explanations advanced to date (including our own attempts) has been terribly convincing. Most explanations tend to be clever but empirically inadequate and, more troublesome still, tend to fix one puzzle at the expense of creating others" (2000, p. 349). Their assessment and comment remain largely valid today in that the puzzle remains largely unresolved despite the proliferation of empirical studies that apply sophisticated econometric techniques. In addition to the appropriate econometric methods, we believe, the relevant economic theory, economic history and institutions – particularly the exchange rate regime – and the history of economic doctrines are also essential elements for us to have a better understanding of the Feldstein-Horioka puzzle before we can come up with a genuine solution to the puzzle. In our view, such broad knowledge should not be confined to resolving this particular puzzle only and it should be more generally and widely applied in addressing international capital flows as well as other issues in monetary economics or macroeconomics.[1]

By contrast, theoretical attempts to resolve the puzzle are relatively fewer, and most of them are based on the intertemporal approach to the current account or its variants (e.g. see *Obstfeld* and *Rogoff* 1995 for a survey of this approach). Similar to the empirical studies, the theoretical works have not yet come up with any consensus and hence the puzzle remains unresolved.

Like the original Feldstein-Horioka study, almost all of the subsequent studies, whether theoretical or empirical, are implicitly based on the national income accounting identities and focus on the real sector. Simply put, they have downplayed the role of money or the monetary sector in the saving-investment correlation and international capital flows. Methodologically, two important strands of literature in monetary economics, namely the monetary loanable funds theory and the monetary approach to analysing balance of payments and exchange rates are neglected, if not forgotten and lost, by almost all studies in the current literature on the Feldstein-Horioka puzzle.[2]

A main objective of this study is to take money seriously and re-incorporate it into the theoretical and empirical framework. The role of money in affecting the balance of payments, capital movements and exchange rates has long been recognized and the origin of the monetary approach is generally attributed to Hume's price-specie-flow mechanism (1752 [1963]), a building block of classical monetary economics. In fact it can be traced back even earlier to an analysis by Dudley North (1641 – 1694), which is highly relevant to the current study. According to North, the demand for loanable funds consists of consumer loans,

[1] For example, *Dellas* and *Tavlas* (2018) recently reexamine the debate of monetary rules by referring to the monetary history since 1880, the institutional arrangements of the exchange rate regimes and the economic thinking of Milton Friedman. Their analysis and discussion offer insights for understanding the feasibility and suitability of the celebrated Taylor rule as a rule that can achieve simultaneously full employment, price stability and democratic accountability.

[2] *Carvalho* (2019) has found a strong statistical relationship between international capital flows and growth in domestic credit and in money for a sample of OECD and non-OECD countries over the period 1999 – 2007. This study, however, focuses on financial integration and banking stability and does not explicitly address the Feldstein-Horioka puzzle.

government borrowing, and borrowing by foreigners, whereas the supply of loanable funds comprises savings, dishoarding, injection of new money, and inflows of foreign money capital.[3] Partly due to the Keynesian revolution, the importance of money had been to some extent downplayed until its revival later by the monetary approach to the balance of payments and exchange rate determination advocated by *Frenkel* and *Johnson* (1976), among others. Following *Laidler* (1985), however, the monetary approach used in this study simply refers to a method or approach to analysing the balance of payments and exchange rate issues which in general emphasizes the interaction of demand for and supply of money. The term is used in a very general sense and does not necessarily refer to any particular school of thought in the literature.[4] The monetary approach was later displaced and dominated by the New Open Economy Macroeconomics. Details of the NOEM can be found in, for example, *Obstfeld* and *Rogoff* (1996), *Lane* (2001), and *Vanhoose* (2004). Whatever new approach or framework is used, only a handful of studies in the literature have explicitly considered the role of money in explaining the Feldstein-Horioka puzzle. For example, *McClure* (1994) uses an IS-LM model to show that a high correlation between saving and investment, or put differently a low variability of the current account, can result even under high capital mobility if the central bank pegs the domestic interest rate to the foreign interest rate. On the other hand, *Schmidt* (2007) derives a two-country DSGE model under the NOEM framework and the simulation results indicate that for the country originating monetary policy shocks, its saving and investment responses can be highly correlated. Such a simulation finding is consistent with the empirical results based on VARs by *Kim* (2001).

Similar to the monetary approach, money also plays an important role in the loanable funds theory, which has also been long recognized by classical writers like *Thornton* (1802[1939]) and the above-mentioned work by North. The loanable funds theory remains in the mainstream more than a century later in the works of renowned economists like *Wicksell* (1936), *Robertson* (1937), *Ohlin* (1937), and *Tsiang* (1988) to name just a few. But unfortunately just like the monetary approach, this theory is no longer fashionable in the mainstream today. In the monetary loanable-funds model, both real variables like saving and investment as well as the demand for and supply of money are determinants of the interest rate. These factors in turn will affect international capital mobility in

[3] See Sir Dudley North's *Discourses Upon Trade*, quoted in *Aschheim* and *Hsieh* (1969, p. 142).

[4] *Frenkel* and *Johnson* (1976) is commonly accepted as a representative work of the so-called modern monetary approach associated with the Chicago School. *Tsiang* (1977) offers a critique to this modern approach and also points out that there were already post-WWII works analysing the monetary influence on the balance of payments and exchange rate before the rise of this modern monetary approach. See also *Polak* (2001).

an open economy framework. This monetary loanable funds view differs from Feldstein and Horioka's view of capital market integration, which is largely based on the real sector and also on the national income and balance-of-payments identities. Recognizing this main difference, *Levi* (1996) points out that the missing variables – money supply and demand – in the original Feldstein-Horioka regression specification can be a potential source of bias. Although his insight is most likely to be correct, he does not provide any further theoretical analysis and empirical evidence.

Based on Levi's penetrative insight and from a monetary doctrinal perspective that money does matter in the classical and neo-classical orthodoxy, this study examines the Feldstein-Horioka puzzle by resurrecting the important role of money into the analytical and empirical framework. Admittedly, both its scope and objective are modest. It does not aim at obtaining a very precise and accurate estimate of the saving-investment coefficient or resolving the Feldstein-Horioka puzzle once and for all, simply because there are other puzzles closely related to the Feldstein-Horioka puzzle, such as the Frankel-Dooley-Mathieson puzzle (see, for example, *Dooley* et al. (1987), *Hamori* (2007) and *Chu* (2017) for details) that certainly requires further research. Instead, we hope that the theoretical analysis and empirical evidence of this study can contribute to the literature by shedding new light on the Feldstein-Horioka puzzle.

The organization of this paper is straightforward. The next section will expound the theoretical framework and derive the model specification for empirical analysis. This is followed by panel data regressions based on 20 OECD countries for the period 1960–74 and the empirical findings, which indicate clearly that not only domestic saving but also the monetary factors are significant determinants of domestic investment. As usual, the paper ends with some concluding remarks.

II. The Theoretical Framework

Feldstein and Horioka's use of the savings-investment correlation as a measure of international capital market integration is based on the national income identity:

$$Y = C + I + G + (EX - IM) \tag{1}$$

with the standard notation. Noting that $S = Y - C - T$ and substituting Y into Equation (1) gives

$$S - (G - T) = I + (EX - IM) \tag{2}$$

From the balance-of-payments accounting identity and assuming no measurement errors and omissions, the current account balance and the capital and financial account balance (hereafter capital account for simplicity) should sum to zero in the accounting sense:

$$(EX - IM) + KA = 0 \tag{3}$$

where ($EX - IM$) is a proxy for the current account (CA),[5] and KA stands for the capital account balance. Therefore,

$$I = S - (G - T) - CA = S + (T - G) + KA \tag{4}$$

Hence domestic investment is related to national savings (i. e., private saving, S, plus government saving or surplus, $T - G$) and capital account balance (net capital inflows or outflows, depending on whether KA is a surplus or a deficit). In the extreme case where capital is perfectly immobile internationally, domestic saving and investment are perfectly positively correlated. Without loss of generality, therefore, the saving-investment correlation can be regarded as a measure of international capital mobility or market integration according to the Feldstein-Horioka hypothesis.

However, the above Feldstein-Horioka postulation is incomplete, if not incorrect, because it focuses on the real sector only but ignores the monetary sector. Feldstein and Horioka's influential paper was written and published at a time when the world economy was under floating exchange rates. Their intuition and hypothesis would probably be correct if it was a *pure* floating exchange rate regime and also if central banks kept the monetary aggregates intact. However, the sampling period in their study is in fact the years 1960–74, a period during which the world economy was under *fixed* exchange rates or at best *managed floating* rates after the beginning of the collapse of the Bretton Woods System in August 1971; for during 1971–74, the early years of floating rates, central banks managed their currencies and exchange rates such that it was not a pure floating exchange rate regime. This historical and institutional background means that we have to appropriately modify Feldstein and Horioka's intuition and hypothesis.

[5] By definition, current account balance is the sum of trade balance and net factor payments from abroad, i. e. $CA = (EX - IM) + NFP$. Here for simplicity, we follow the majority of studies in the literature and assume that NFP is negligible. This practice and assumption are not unreasonable for the OECD countries during the sample period under study. For countries which have many citizens working abroad or for periods during which globalization is prevalent, it may be more appropriate to have NFP explicitly stated in the equation and subsequent theoretical and empirical analyses, depending on the objective of research. Nevertheless, the inclusion of NFP is highly unlikely to affect the key findings and conclusion of the current study.

Therefore, the above theoretical framework is modified accordingly in order to capture the monetary influence under the prevailing exchange rate regime during the period under study. In practice, the balance-of-payments accounting identity is more usefully represented as

(5) $$CA + KA + BOF = 0$$

where *BOF* is the official settlement balance, i. e., the net change in the central bank's gold and foreign exchange reserves resulting from all transactions recorded in the current and capital accounts, and *KA* now represents private international capital flows. In other words, when a country runs a current account deficit, for example, it can pay for it by having a capital account surplus (net capital inflow) or by drawing down its gold and foreign exchange reserves. For one reason or another, the *BOF* is not considered in Feldstein and Horioka's analysis – perhaps they regarded BOF as less important in magnitude when compared with other capital account items and hence it could be suppressed and grouped in *KA*, or they might have implicitly assumed in their analysis a pure floating exchange rate regime and also no change in the central bank's monetary policy or any intervention in the foreign exchange market such that $BOF = 0$, or whatever other possible reasons not explicitly spelled out by them.

Now if we replace Equation (3) by Equation (5), then Equation (4) will become

(6) $$I = S - (G - T) + KA + BOF = S + (T - G) + KA - \Delta FR$$

where $-\Delta FR$ represents depletion of the central bank's gold and foreign exchange reserves. The monetary factors now enter this equation because changes in foreign exchange reserves affect the monetary base and hence the domestic money supply. All other things equal, a depletion in the central bank's asset holding of gold and foreign exchange reserves, say, due to a current account deficit larger than the net capital inflows, causes a correspondent decrease in the central bank's liabilities in terms of monetary base or high-powered money. The latter change will in turn cause a decrease in commercial banks' holding of monetary base and hence contractions in their loans and deposits (and consequently the money supply) through the money supply multiplier process. This example illustrates how the BOF can induce changes in domestic credit (assuming for simplicity that the banking system is initially in equilibrium with no excess reserves) without taking into consideration the central bank's monetary policy stance and reaction (e. g. sterilization). We shall return to this issue very shortly, but let us first incorporate formally and explicitly the monetary factors into the Feldstein-Horioka framework.

Consolidating the balance sheets of the central bank and commercial banks gives

$$\Delta FR + \Delta DC = \Delta M \tag{7}$$

where M is the money supply and DC is domestic credit creation of the whole banking system.[6] In its simplest form, DC is the sum of the central bank's loans to the government (or its holding of government debt) and commercial banks' loans and advances to the personal and corporate sectors. First pioneered by *Johnson* (1958), the above equation is the now standard accounting identity showing the link between the balance of payments and the money supply in an open economy. Now substitute $-\Delta FR$ from Equation (7) into Equation (6) to get

$$I = S + (T - G) + KA + \Delta DC - \Delta M \tag{8}$$

The above equation is no longer a mere ex post accounting identity because how changes in foreign exchange reserves would be translated into changes in the domestic credit creation and the money supply depend not only on the behaviour of the banking system and the non-bank public but also on the central bank's monetary policy stance and attempts at sterilization.

In our example above, the central bank can possibly offset or sterilize the contractionary impact on the domestic money supply due to the BOF deficit by carrying out open market purchases of government bonds. Conversely, in the case of BOF surplus, the central bank can engage in open market sales. In general, such defensive open market opreations can offset movements in other factors affecting the monetary base. Theoretically speaking, the central bank is able to completely sterilize, or neutralize, any reserve flows by changing the domestic

[6] Equation (7) is derived by a consolidated balance sheet for the banking system as a whole – central bank plus commercial banks. The central bank's simple balance sheet can be represented as FR + DC_g = Cur + Res, where FR is foreign exchange reserves, DC_g is the central bank's domestic credit creation (e.g. lending to the government by holding government debt), Cur is currency issued and Res is commercial banks' reserves held at the central bank. By definition, the right-hand side of the above balance sheet equation is the monetary base or high-powered money, which is backed by the central bank's assets – foreign exchange reserves and government debt – on the left-hand side. If for simplicity we assume away bank capital, then the balance sheet of the commercial banks can be represented as Cur_b + Res + DC_b = Dep, where Cur_b is currency held by commercial banks, DC_b is the commercial banks' loans and advances and Dep is bank deposits held by the public. Adding the above two balance sheet equations, we get FR + DC_g + Cur_b + Res +DC_b = Cur + Res + Dep. Or FR + (DC_g + DC_b) = (Cur–Cur_b) + Dep. The terms in the parentheses on the left-hand side is known as domestic credit creation, i.e., DC = DC_g + DC_b, whereas the terms in the parentheses on the right-hand side, i.e., (Cur–Cur_b), is simply currency in public circulation. By definition, the right-hand side is the money supply M. Therefore, we have FR + DC = M or ΔFR +ΔDC = ΔM.

credit accordingly such that the monetary base, and hence the money supply, remains intact. In this polar case of complete sterilization, the net change in foreign exchange reserves, i.e., $\Delta FR = 0$, as a result of both reserve flows and sterilization. It follows from Equations (6) and (7) that Equation (8) will be reduced back to Equation (4), i.e., the original Feldstein-Horioka specification without any monetary factors. Whether sterilization can be successful or not, however, is controversial in both theory and practice. In particular, the central bank's ability to sterilize the effects of BOF and control the money supply in the long run under fixed exchange rates is questionable, because the central bank cannot choose the domestic money supply as an independent policy target if it decides to maintain the official exchange rate at the same time.

According to the Chicago monetary approach to the balance of payments, however, sterilization is infeasible and the balance of payments is essentially a monetary phenomenon; for a balance-of-payments disequilibrium – current account imbalance and capital flows – is due to discrepancy between domestic credit creation and the real cash balance held by the private sector. The *flow* of foreign currency reserves in or out of an economy under a balance-of-payments disequilibrium is a transient phenomenon reflecting the adjustment in the *stock* of money towards a long-run equilibrium. The gap between the demand for domestic currency and the supply generated by the central bank and the banking system is filled up the foreign currency reserves. Given a stable money demand function, an excess supply of money due to domestic credit expansion will lead to a balance-of-payment deficit or an outflow of reserves, and an inflow in the case of excess demand for money. Put differently, under the monetary approach to the balance of payments, domestic monetary policy will cause flows of money internationally (see, for example, *Johnson* 1972, and *Frenkel* and *Johnson* 1976 for details).

Needless to say, not all economists – even among the proponents of a monetary approach themselves – agree to the above view, not to mention adherents of other approaches, such as the elasticity approach or the absorption approach, who argue instead that the balance of payments is a real phenomenon.[7] Nevertheless, Equation (7) indicates clearly that imbalances on an economy's current or capital accounts with the rest of the world can have monetary implications even if the sources of imbalances arise from the real sector rather than the monetary sector. The extent of the monetary effects depends on how successful the central bank's attempts at sterilization to neutralize the effects of balance-of-pay-

[7] *Polak* (2001) documents and compares two monetary approaches to the balance of payments developed in the IMF and the University of Chicago. Although the two approaches share certain common elements, like money demand, money supply and in particular our Equation (7), in their models and reach the same policy conclusion, they differ in economic reasoning. For more details, see *Polak* (2001).

ments disequilibrium and hence to keep the domestic money supply intact. Both theory and empirical evidence remain controversial; however, they tend to suggest that under fixed exchange rates central banks are able to sterilize a certain fraction of reserve or capital flows in the short run only as long as the ΔFR is relatively small in magnitude and also the spot exchange rate can be kept within ±1 % of the official parity; and it is questionable if central banks can fully offset international capital flows in the long run because sterilization can lead to vicious circles of currency flows.[8]

While the adjustment mechanism remains controversial, the above analysis shows that the connection between money and international capital flows cannot be denied under most circumstances regardless of whether the original source of balance-of-payments disequilibrium is monetary or real. Depending on the fraction of reserve flows that can be offset, sterilization can range from no sterilization to complete sterilization. But as long as sterilization is not complete, the monetary factors ΔDC and ΔM will not vanish in Equation (8), indicating a connection between international capital flows and the domestic money supply. The same relationship can also be derived from the flow-of-funds accounts or the credit counterparts approach to money supply determination. See, for example, Artis and Lewis (1991, pp. 154 – 63) for details.

The result derived above is consistent with not only the results based on the flow-of-funds accounts but also the monetary loanable funds theory. More than two centuries ago, *Thornton* (1802) already related the demand for money balances, or more commonly known as hoarding in the older literature, to the rate of interest. According to the classical or neoclassical writers, the interest rate in the short run is determined by not only investment and saving but also changes in the demand for and supply of money (e. g. *Wicksell* 1936, *Robertson* 1937 and *Ohlin* 1937). When applied to open economies, examples of this extended monetary loanable funds theory include *Tsiang* (1977, 1988) and *Levi* (1996). According to the monetary loanable funds theory, the interest rate is determined in a *flow* equilibrium when the demand for loanable funds equals the supply. In contrast, this theory differs from Keynes' liquidity preference theory and the modern monetary approach to the balance of payments and exchange rate determination, where the equilibrium is attained when the *stock* of money supply equals to the demand for money balances. *Patinkin* (1965) argues that the two theories are equivalent in a Walrasian general equilibrium. This view is, however, by no means consensual. For example, *Tsiang* (1966) is a staunch defender of the inapplicability of Walras' Law to monetary economics, whereas *Laidler* (1989, 1990) argues that monetary exchange and Walrasian markets are alternative rather than complementary arrangements for coordination of economic ac-

[8] See, for example, Germany's experience of unsuccessful attempts at sterilizing currency flows in the 1960s (see, e,g, *Kouri* 1975 for details).

tivity. It is not the right place here to re-examine in detail the debate in the literature on the nonequivalence of the liquidity preference and loanable funds theories of interest rate. It suffices for our purpose that so long as the two theories are not equivalent, at least in the short run or during the adjustment period towards the long-run steady-state equilibrium under which the two theories would be equilibrated, the role of money should not be downgraded or ignored in the analysis.

In sum, from an institutional perspective (i. e. flow-of-funds analysis) or a historical perspective on the development of monetary doctrine, or both, we should not simply focus on the real factors only and ignore the monetary factors in our attempt to resolve the Feldstein-Horioka puzzle. Comparing Equation (8) with Equation (4), it is apparent that the Feldstein-Horioka original framework omits the monetary factors, i. e., changes in domestic credit creation and in the money supply. It follows that their regression results are potentially subject to variable omission bias. We now turn to empirically examine if this is indeed the case.

III. Empirical Methods and Results

1. Model Specification and Panel Unit Root Tests

From the above theoretical analysis, the Feldstein-Horioka regression equation can be modified to incorporate the monetary variables and specified as follows:

$$\left(\frac{I}{Y}\right)_{it} = \beta_0 + \beta_1 \left(\frac{S}{Y}\right)_{it} + \beta_2 \left(\frac{\Delta M}{Y}\right)_{it} + \beta_3 \left(\frac{\Delta DC}{Y}\right)_{it} + \varepsilon_{it} \tag{9}$$

where ε_{it} is a random disturbance term, and other variables are standard or the same as previously defined. Based on the theoretical results derived from Equation (8), it is postulated that $\beta_1 > 0$, $\beta_2 < 0$, and $\beta_3 > 0$. In the monetary loanable funds framework, an increase in saving, ceteris paribus, means more loanable funds can be used to finance domestic investment, and hence $\beta_1 > 0$. Likewise, more loanable funds will be available to finance domestic investment when domestic credit is created, and therefore $\beta_3 > 0$. Conversely, less loanable funds will be available when money hoarding increases, and so $\beta_2 < 0$. If it is empirically found that *both* $\beta_3 = \beta_2 = 0$, then the above model is simply theoretically incorrect in that monetary factors do not matter, or alternatively the theory is correct but in practice the central banks were always able to successfully carry out *complete* sterilization to offset the impact of the monetary factors.

The sampling period of our empirical analysis is the same as Feldstein and Horioka's, i. e., the years 1960–74 and the original 20 OECD countries (see Data Appendix for more details). A main purpose of this sampling choice is for the purpose of comparing our empirical results with theirs. Another reason is for analytical tractability because there was apparently a structural or regime change into a floating exchange rate regime after 1974 and hence both the theory and empirical methods have to be extended and modified if the sample extends beyond 1974.[9] Although the sample is essentially the same, our econometric methods differ from theirs. In the original *Feldstein-Horioka* (1980) cross-sectional study, they carried out their econometric estimation based on data averaged out over the business cycle as a means to minimize the bias due to omitted variables. However, this method of "long-run" analysis is unable to capture the monetary loanable funds theory (see explanations below). Therefore, we use instead panel data econometric methods (see e.g. *Baltagi* (2013) and *Pesaran* (2015a) for details) in order to capture the dynamics of the saving-investment nexus over time. Nonetheless, for the purpose of comparison and analytical tractability, we keep our empirical methods as basic, simple and appropriate as possible and avoid any unnecessary complication.

Table 1 reports the summary descriptive statistics of the four variables as specified in Equation (9) above for the 20 OECD countries over the years 1960 – 74. On the surface, the means of these variables for each country appear to support the Feldstein-Horioka puzzle and reject ours. For each country, investment and saving are relatively large in magnitude and their means are almost equal to each other, whereas changes in money supply and in domestic credit creation are relatively small in magnitude and close to zero. However, these averages tend to suppress the short-run dynamics. During the period under study, risk management techniques of banks were not as well-developed as they are today. Hence banks tended to avoid holding positions with large gaps between assets and liabilities, because the larger this gap would lead to a larger duration gap and hence higher potential capital value risk due to interest-rate volatility. On the other hand, the fixed exchange rate system imposed discipline on the growth in monetary base. Against this historical and institutional background, changes in depositors' demand for money (deposits), i.e. hoarding or dishoarding, would be more or less matched by correspondent changes in the supply of credit. Changes in money supply and in domestic credit creation are therefore expected to be relatively small in magnitude and they tended to average out over time and close to zero because of the balance-of-payments constraint in the long run.

[9] Based on a panel for 13 OECD countries over 1960 – 2007, *Kumar* and *Rao* (2011) have detected structural breaks in the mid-1970s and early 1990s due to the collapse of the Bretton Woods system in 1971 and the Maastricht Treaty in 1992 respectively.

Table 1

Summary Descriptive Statistics by Country

Variable	*Investment*		*Saving*		*Money Supply Change*		*Domestic Credit Change*	
Country	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*	*Mean*	*Std. Dev.*
Australia	26.54	1.94	24.81	1.48	4.32	2.61	2.32	1.24
Austria	29.58	2.57	28.73	1.45	6.04	1.09	4.84	1.68
Belgium	22.65	1.5	23.61	2.07	3.8	1.01	2.13	0.62
Canada	23.13	1.64	21.82	1.77	5.09	2.5	4.17	2.58
Switzerland	30.88	1.68	31.41	2.63	7.86	5.88	7.76	2.58
Germany	26.16	1.8	27.04	1.11	5.43	0.93	6.77	1.86
Denmark	24.08	1.59	22.03	1.34	4.26	1.33	2.81	0.5
Spain	24.04	1.98	23.92	1.01	12.51	3.88	9.22	2.81
Finland	27.01	2.94	25.24	2.32	4.73	1.25	4.58	1.41
France	25.15	1.39	25.14	0.75	9.43	3.05	4.21	1.49
Greece	25.17	4.54	22.25	4.38	6.23	1.94	2.27	1.03
Ireland	22.45	3.51	19.64	1.98	6.81	4.19	3.83	2.73
Italy	22.72	2.36	23.74	1.43	9.86	2.74	7.84	1.36
Japan	36.19	2.17	36.29	2.11	16.51	8.82	15.49	6.89
Netherlands	26.34	1.29	27.49	1.18	6.56	0.97	4.29	1.35
Norway	29.52	2.23	27.42	0.85	4.57	1.22	5.35	2.76
New Zealand	24.61	3.49	22.04	2.74	1.75	2.3	1.01	108
Sweden	24.32	1.49	24.57	1.02	4.43	1.66	7.59	3.28
UK	19.3	1.36	18.92	1.52	3.13	2.79	2.73	2.61
USA	19.07	0.74	19.43	0.83	5.45	2.02	7.31	1.91
All Countries	25.45	4.46	24.77	4.49	6.44	4.56	5.33	4.08

Note:

1. All figures are in percentage, i.e. $x10^{-2}$.

2. For each country, the number of observations for saving is 15 and the same for investment, whereas it is 14 for money supply change or domestic credit change.

3. For the entire sample, the total number of observations for saving is 300 and the same for investment, whereas it is 280 for money supply change or domestic credit change.

Nevertheless, this does not imply that there is no role for changes in money supply and in domestic credit creation to play in the saving-investment nexus in the short run. The notion of money as a buffer stock is important and insightful in macroeconomic analysis. But unfortunately the buffer-stock approach is largely neglected by mainstream macro-economists except a few (e.g. *Jonson* 1976, *Carr* and *Darby* 1981, and *Laidler* 1984). For at least a couple of reasons, the buffer-stock notion is highly relevant and appropriate in our analysis here.

First, *Levi's* (1976) insight alludes to a divergence, at least in the short run, between the natural interest rate, a la Wicksell, that equates saving and investment, and the money interest rate that is determined by the loanable funds theory. Or simply put, the money market does not clear and is out of equilibrium. Indeed the buffer-stock approach is also sometimes referred to as the disequilibrium money approach for it allows the real world we live in to have occasional departure from the theoretical full equilibrium state.

Second, Feldstein and Horioka's framework focuses only on the flow variables, i.e., domestic savings, investment and international capital flows. Our analytical framework in the previous section shows that the saving-investment nexus involves not only these flow variables but also changes in the stock variables like the money supply (or money stock) and central banks' holdings of foreign exchange reserves. In the buffer stock approach to monetary analysis, economic agents hold inventories of cash balances as shock absorbers during the adjustment process towards the full equilibrium. The approach encompasses both flow and stock variables and equilibria in its analysis and also the underlying theoretical framework is the monetary loanable funds theory – which encompasses both the classical loanable funds theory of saving and investment as well as Keynes's liquidity preference theory.

Back to our problem at hand, in theory the banking system can play a role of shock absorber to accommodate any unexpected discrepancy or disequilibrium between saving and investment in the short run. For instance, if domestic saving and capital inflows are insufficient to finance domestic investment, banks can bridge the gap by extending commercial loans as long as bank reserves are sufficient and it is profitable for banks to do so. This is why we should not omit these monetary variables in the first place in the empirical analysis. And this is also one of the reasons for applying panel data regression techniques instead of cross-sectional regression analysis in order to capture the short run dynamics.

To avoid spurious regression, we first test whether the panel data series are stationary or not. The panel unit-root test results for the variables specified in Equation (9) are reported in Table 2. As can be seen, the *Levin-Lin-Chu* (2002) or LLC test statistics indicate that all panels are stationary and do not contain unit roots. By contrast, the *Breitung* (2000) test results reveal that all series except change in domestic credit creation cannot reject the null hypothesis of pan-

Table 2

Summary of Panel Unit-Root Test Results

Test	*Investment*	*Saving*	*Money Supply*	*Credit Creation*
I. First-Generation Tests				
Null Hypothesis: Unit Root (assume common unit root process)				
Levin, Lin & Chu	–3.5938***	–3.0823***	–5.5426***	–3.4115***
Breitung	–0.3776	3.1011	–0.5511	–2.0258**
Null Hypothesis: Unit Root (assume individual unit root process)				
Im, Pesaran, & Shin	–2.0071**	–1.8350**	–3.8745***	–1.4704*
ADF Fisher χ^2	57.7675**	56.8129**	74.9105***	67.4748***
ADF Choi Z-statistic	–2.1236**	–1.9960**	–3.9168***	–1.3375*
PP Fisher χ^2	46.7615	58.7849**	63.0328**	68.4342***
PP Choi Z-statistic	–1.059	–1.5234*	–3.0071***	–1.9674**
Null Hypothesis: Stationarity				
Hadri Z-statistic	8.0501***	6.6449***	4.5468***	6.9444***
Hadri Heteroscedastic consistent Z-statistic	5.9659***	10.6476***	5.5401***	7.0440***
II. Second-Generation Test				
Null Hypothesis: Unit Root				
Pesaran's CIPS test	0.654	–2.860**	–5.923***	–4.048***

Note:

1. ***, **, and * denote respectively statistical significance at the one-, five- and ten-percent levels.

2. The lag structure used in ADF regressions to compute the test statistics are selected based on AIC.

3. The Bartlett kernel with the maximum number of lags are determined by the Newey-West bandwidth selection algorithm.

el unit roots. Both LLC and Breitung tests assume that each individual time series contains a unit root and has a homogeneous coefficient across cross-sections under the null hypothesis, against the alternative hypothesis that the time series is stationary. When this assumption is relaxed, we have alternative testing procedures under which the null hypothesis is that each series in the panel contains a unit root with a heterogeneous coefficient, against the alternative hypothesis that some (but not all) of the individual time series have unit roots. The test results are reported in Table 2. As can be seen, the Im, *Pesaran* and *Shin* (2003) or IPS test, the Fisher-type tests proposed by *Maddala* and *Wu* (1999) and the tests by *Choi* (2001) all reject the null except in two cases – the PP Fisher χ^2 and the PP Choi Z-statistic for the investment series. On the other hand, Table 2 also reports the results of the *Hadri* (2000) tests. As can be clearly seen, the null hypothesis of no unit root in any of the series in the panel is rejected across the board. In a comparison of the panel unit root tests, however, *Hlouskova* and *Wagner* (2006) find that the Hadri test performs very poorly in small samples whereas the LLC and IPS tests perform better.

All the above tests are commonly known as the first-generation tests and they ignore the correlations among panels. In the last row of Table 2, we also report the results of a second-generation test developed by *Pesaran* (2007), known as the CIPS test that takes into account of correlations among panels. As can be seen, the results are mixed and very similar to those of the Fisher PP χ^2 and the PP Choi Z-test in that all the series except investment are stationary.

In sum, the panel unit root test results are mixed. For small T as in our sample here, panel unit root tests have low power and there is the potential risk of concluding that the entire panel is nonstationary even though a large proportion of stationary series exists in the panel (*Karlsson* and *Löthgren* 2006).

Given our small sample size and the low power of panel unit tests, we adopt the following strategies for the empirical analysis to follow. On the one hand, we carry out the traditional, standard panel data econometric analysis under the assumption that the panel is stationary. On the other hand, we also carry out panel cointegration tests and regressions under the assumption that the panel is nonstationarity. It is hope that careful analysis of these two sets of results can enable us to adequately validate our theoretical model developed above.

2. Stationary Panel Regression Results

Based on Equation (9), a pooled OLS regression is first run and the test results for country and time effects are reported in Table 3. The panel regression results for the error component model are tabulated as Table 4. For the purpose of comparison, the original Feldstein-Horioka cross-section regression equation is also run and the results are reported in the first column of Table 4, whereas the second column reports the cross-sectional regression results for Equation (9) based on the averages of the variables for each country instead of the panel data. The results show that investment is related to saving only, whereas both money supply and domestic credit creation have the wrong signs and are statistically insignificant. These results are erroneous for the specification omits other potential variables affecting domestic investment.

Table 3

Summary of Langrangean Multiplier Test Results of Individual and Time Effects

	Model Represented by Equation (9)			*Model with Dummy Variable for 1974*		
Test	*Individual*	*Time*	*Both*	*Individual*	*Time*	*Both*
Breusch-Pagan	135.22***	7.38***	142.60***	146.38***	0.035	146.42***
Honda	11.63***	2.72***	10.14***	12.10***	–0.186	8.42***
King-Wu	11.63***	2.72***	9.51***	12.10***	–0.186	7.57***
SLM	12.01***	3.33***	---	12.49***	0.158	---
GHM	---	---	142.60***	---	---	146.38***

Note: *** denotes statistical significance at the one-percent level.

With panel data, we can capture the omitted variables in terms of a two-way error component model. A pooled OLS regression is first run and the results are reported in the third column of Table 4. Based on this specification, the individual (country) and time (year) effects are tested and reported in the first three columns of Table 3. All the Langrangean multiplier tests clearly indicate the presence of both individual and time effects. This finding is highly plausible. Domestic investment is affected by country-specific factors like infrastructure, government regulation, rule of law, etc. On the other hand, certain time-specific effect, for example the devaluation of the sterling pound in 1967, the beginning of floating exchange rates in 1971, and the OPEC oil price hike in 1973, to name just a few, could also affect investment behaviours. Both two-way fixed effects (FE) model and two-way random effects (RE) model are estimated. However, the Hausman specification test statistic – at a value of 12.43 – suggests the adoption of the FE model instead of the RE model. For brevity, the results of the RE model are unreported and only those of the FE model are reported in Column 4 of Table 4.

For the FE model, all the explanatory variables have the correct signs as predicted by our theory. Domestic saving is the most important determinant in terms of the magnitude of its coefficient. It is also statistically significant in terms of all the three t-statistics computed from (i) the OLS residuals, (ii) the White robust covariance matrix that assumes the errors are contemporaneously, cross-sectionally correlated and heteroskedastic, and (iii) another White robust covariance matrix that assumes the errors for a cross section are heteroskedastic and serially correlated. In contrast, both change in money supply and change in domestic credit creation have much smaller impact on investment in terms of magnitude, and also the coefficient of the former is statistically insignificant whereas the latter is only marginally significant. The statistical insignificance

Table 4

Panel Data Estimation Results

Model	*Original FH Regression Model*	*OLS based on Averages*	*Pooled OLS based on Eq. (9)*	*LSDV with both Country & Time FE*	*EGLS with Country FE*	*Pooled OLS with 1974 Dummy*	*LSDV with Country FE*	*LSDV Mixed Model*	*EGLS with Country FE*
Intercept	0.0316	0.0182	0.0363	0.08	0.0791	0.0556	0.1045	0.1042	0.0895
	(1.71)†	–0.9	(4.55)***	(4.62)***	(6.06)***	(6.16)***	(6.68)***	(6.65)***	(6.72)***
	[2.02]*	[1.09]	[4.03]***	[7.55]***	[5.97]***	[6.72]***	[8.36]***	[8.43]***	[7.99]***
			[2.05]**	[2.41]**	[3.26]***	[2.79]***	[2.83]***	[2.80]***	[3.67]***
Saving	0.9009	0.9844	0.8977	0.6943	0.7034	0.9006	0.6796	0.6796	0.7181
	(12.3)***	(10.4)***	(25.16)***	(9.92)***	(12.97)***	(25.98)***	(10.88)***	(10.91)***	(13.17)***
	[15.67]***	[12.03]***	[22.41]***	[14.91]***	[13.16]***	[23.70]***	[12.52]***	[12.64]***	[15.99]***
			[11.37]***	[4.69]***	[6.68]***	[11.37]***	[4.36]***	[4.35]***	[6.78]***
ΔMoney		0.0994	–0.0512	–0.0416	–0.0889	–0.0243	–0.0764	–0.0738	–0.0979
		–0.64	(–1.18)	(–0.90)	(–2.64)***	(–0.57)	(–1.70)*	(–1.66)*	(–2.77)***
		[0.73]	[–1.39]†	[–1.17]	[–3.18]***	[–0.52]	[–1.80]*	[–1.77]*	[–3.40]***
			[–0.78]	[–0.87]	[–2.30]**	[–0.40]	[–1.46]*	[–1.43]†	[–3.16]***

ΔCredit		−0.257	−0.012	0.1069	0.1377	−0.0512	0.0933	0.0937	0.1152
		(−1.50)†	(−0.24)	(1.80)*	(3.48)***	(−1.03)	(1.67)*	(1.69)*	(2.68)***
		[−1.75]*	[−0.28]	[1.62]†	[3.22]***	[−1.53]†	[1.88]*	[1.86]*	[3.16]***
			[−0.16]	[1.15]	[2.83]***	[−0.73]	[1.11]	[1.10]	[1.95]*
Yr 1974						−0.0212	−0.0193	−0.0193	−0.0133
						(−4.17)***	(−4.57)***	(−4.43)***	(−4.53)***
						[−14.65]***	[−12.32]***	[−12.26]***	[−13.29]***
						[−2.87]***	[−2.57]**	[−2.46]***	[−3.08]***
Adj. R^2	0.8928	0.8911	0.7515	0.8469	0.9205	0.7654	0.8434	0.8436	0.907
S.E.E.	0.0133	0.0131	0.0221	0.0173	0.0182	0.0215	0.0175	0.0175	0.0174
F-stat.	149.98***	52.81***	282.18***	45.10***	147.78***	228.53***	66.32***	66.42***	119.29***
Test for Fixed Effects				6.38***	12.78***		8.21***	8.24***	12.53***
Hausman Test				12.42***		12.15***		7.52*	
Pesaran CD Test			4.56***	2.16**	4.25***	0.977	1.031	1.064	0.75

Note:

1. ***, **, * and † denote respectively statistical significance at the one-, five- ten- and twenty-percent levels.
2. Figures in parentheses are t-statistics computed from the OLS residuals
3. Figures in brackets are t-statistics computed from the White robust covariances; the top ones assume that the errors are contemporaneously, cross-sectionally correlated and heteroskedastic, whereas the bottom ones assume that the errors for a cross section are heteroskedastic and serially correlated.

may be partly due to the attenuated problem of multicollinearity arising from too many individual and time dummy variables. Nevertheless, the test results for fixed effects also indicate that the dummy variables are relevant. If this FE model is the true model, the OLS on Equation (9) (i.e., results reported in Column 3) will yield biased and inconsistent estimates of the regression parameters because of omitted variables. Put differently, the reported saving coefficient of 0.8977 is an overestimate whereas the FE model suggests a consistent estimate of 0.6943 (Column 4).

As alternative specifications to the above two-way FE model, we estimate (i) a mixed model in which the individual country effects are fixed and the time effects are random, and (ii) a feasible GLS model with individual country fixed effects with cross-section weights correcting for cross-section heteroscedasticity. As the two sets of results are both quantitatively and qualitatively similar, only the GLS results are reported here as Column 5 in Table 4 for brevity. Compared with the two-way FE model, the results show improvements in that all the explanatory variables have the correct signs as predicted by the theory and they are also statistically significant. Moreover, the magnitudes of the coefficients are economically reasonable. For example, an increase in the saving rate by one unit would, all other things equal, lead to an increase in the investment rate by approximately 0.70. The extent of international capital mobility is thus higher than that suggested by the original Feldstein-Horioka coefficient of 0.89, although it is still far from perfect capital mobility in which the coefficient should theoretically be equal to zero. Although our findings suggest a higher degree of international capital mobility than Feldstein-Horioka's finding, the OECD countries still had a low degree of international capital mobility during the period under study if we use the 0.6 cut-off level suggested by *Montiel* (1994).

Our findings for the saving-investment coefficient, however, are not entirely incompatible with international monetary history and facts. Capital movements were never free from restrictions or interventions during the period under study. For instance, the British post-war exchange control on long-term capital flows was not lifted until 1979, and the United States imposed restrictions – the Interest Equalization Tax, the Voluntary Foreign Credit Restrain Program and the Foreign Direct Investment Program – on capital flows over the years 1964–74 (for details, see, e.g., *Tew* 1985).

Besides domestic saving, domestic credit creation is also a means to finance domestic investment, and an increase in domestic credit creation by one unit would lead to an increase in domestic investment by 0.14 units. In contrast, a one-unit increase in the money supply would lead to a decrease in investment by about 0.09 units only. This can be attributable to hoarding of loanable funds in the form of currency and deposits in the banking system.

Historically, there was a regime change in the exchange rate system during the period under study. The Bretton Woods system was subject to pressure starting in 1971 when the US government closed the gold window and some major currencies like the British pound, Swiss franc and Japanese yen started to float. The Bretton Woods system subsequently collapsed, resulting in a switch from fixed to floating exchange rates. However, it is perceivable that central banks managed their currencies and exchange rates in the early years of floating rates such that it was not a pure floating exchange rate regime. So the above theoretical framework about changes in the foreign exchange reserves and domestic credit creation and changes in the money supply should still be empirically applicable, at least for the years 1971 – 1974. The gradual structural changes are expected to be captured by the time dummies. To explore this regime change over time, we examine the dummy variables representing the time effects from the above LSDV regression model and find that the time effect for 1974 is statistically different from those for other years. Accordingly, a dummy variable for 1974 is used to replace the time effects and the above regression analysis is repeated. The pooled OLS with the 1974 dummy variable is reported in Column 6 of Table 4. Once again, the Hausman specification test result suggests the adoption of the FE model rather than the RE model. On the other hand, by adding the 1974 dummy variable our modified specification is supported by the results reported in the last three columns of Table 3, which clearly indicate the presence of individual effects but no time effects.

Therefore, we proceed with estimating a LSDV model with fixed individual effects only, a mixed model with individual fixed effects and random time effects, and also a feasible GLS model. The regression results are reported respectively in the last three columns of Table 4. As can be seen, the results are qualitatively similar to those without the 1974 dummy variable but have shown some improvements in terms of statistical significance. As before, all the explanatory variables have the correct signs as predicted by the theory and they are also statistically significant. Moreover, the magnitudes of the coefficients remain economically reasonable. Those for domestic saving, change in money supply and change in domestic credit creation are similar to their counterparts reported earlier. The 1974 dummy variable reflects that domestic investment as a percentage of GDP declined by about one to two percent in 1974 as a result of the world recession following the collapse of the Bretton Woods system and the OPEC oil price hike during these turbulent years.

The above results based on traditional panel data econometrics assume cross-sectionally independent errors and homogeneous slope coefficients. In reality, cross-country dependence is expected to exist because of various reasons, such as economic and political spillovers, increased economic integration between economies, etc. Although the *Pesaran* (2004) CD test has good small sample properties (*Pesaran* 2015b) and the results reported in Table 4 do not reject

Table 5

Regression Results for the G-10 Countries

Model	*LSDV with Country Fixed Effect*	*GLS with Country Fixed Effect*
Intercept	0.1325	0.136
	(6.60)***	(45.10)***
	[4.21]***	[73.67]***
	[3.13]***	[51.47]***
Saving	0.4886	0.4729
	(6.07)***	(37.80)***
	[3.56]***	[59.36]***
	[2.63]***	[42.92]***
ΔMoney	–0.0495	–0.0564
	(–1.14)	(–13.35)***
	[–1.27]	[–16.89]***
	[–1.41]	[–16.21]***
ΔCredit	0.0635	0.0718
	–1.16	(13.94)***
	[0.85]	[28.94]***
	[0.75]	[16.16]***
Year 1974	–0.0065	–0.006
	(–3.40)***	(–19.33)***
	[–0.82]	[–64.53]***
	[–1.50]†	[–23.64]***
Adj. R^2	0.9187	0.9938
S.E.E.	0.0143	1.036
F-statistics	124.42***	1758.69***
Jarque-Bera Test	1.79	0.022
Pesaran CD Test	–0.54	0.473
Breusch-Pagan LM Test	109.06***	5.07

Note:

1. ***, **, * and † denote respectively statistical significance at the one-, five- ten- and twenty-percent levels.

2. Figures in parentheses are t-statistics computed from the OLS residuals

3. Figures in brackets are t-statistics computed from the White robust covariances; the top ones assume that the errors are contemporaneously, cross-sectionally correlated and heteroskedastic; whereas the bottom ones assume that the errors for a cross section are heteroskedastic and serially correlated for the LSDV and cross-section SUR (PCSE) for the GLS.

the null hypothesis of no cross-section dependence for the last four models, these findings are not robust if other tests, e. g. the Breusch-Pagan test, are used instead. To take into consideration the potential cross-country dependence, we estimate a GLS model based on the assumption of contemporaneous covariances of the errors between cross sections for a subsample of the original G-10 countries over the same period of 1960 – 1974. Technically we are not able to apply the full sample in the estimation because the variance-covariance matrix is not invertible when the number of time period is less than the number of cross-section. Though commonly referred to as the Group of Ten or G-10, the original members in 1964 included 11 countries, namely Belgium, Canada, France, Germany, Italy, Japan, Netherlands, Sweden, Switzerland, the United Kingdom and the United States. As they were the largest advanced economies, we hope the empirical results are quite representative and reflect the extent of international capital mobility during the period under study. The regression results are reported as Table 5.

The first column of Table 5 reports the results for the LSDV model with country fixed effects. This is the same model as in Column 7 in Table 4 except that it is based on a subsample rather than a full sample. Although the signs of the coefficients remain correct as predicted by the theory, only saving and the dummy variable for 1974 are statistically significant. The second column reports the results for a GLS model with cross-section SUR weights. By sharp contrast, all the coefficients have the correct signs and are statistically significant. Both the Pesaran CD test and the Breusch-Pagan LM test indicate that the residuals are not cross-sectionally correlated. For both sets of results, an interesting finding is that the saving-investment coefficients are about 0.5, suggesting a relatively high degree – or at least not counterintuitive or counterfactual – of international capital mobility among the G-10 countries.

3. *Panel Cointegration Tests and Estimation*

To take into consideration the possibility that the panel is in fact non-stationary and also there is a possible long-run relationship between the variables, we proceed further with the cointegration tests and estimation. Table 6 reports the results for the various panel cointegration tests. The results of the *Pedroni* (1999) tests are mixed as only three out of the 11 tests reject the null hypothesis of no cointegration. By contrast, the residual-based panel cointegration test of *Kao* (1999) apparently rejects the null, whereas both the Fisher panel Johansen cointegration trace test and maximum eigenvalue test reject the null hypothesis of no cointegration as well as the null hypotheses of at most one, two or three cointegration relationships. Based on the last two sets of results, we are willing to entertain the possibility that a long-run relationship among the variables can

Table 6

Results of Cointegration Tests

I. Pedroni Residual Cointegration Tests		
Alternative hypothesis: Common AR coefficients (within-dimension)		
	Statistic	*Weighted Statistic*
Panel v-statistic	−1.1214	−2.2183
Panel rho-statistic	2.3059	2.255
Panel PP-statistic	0.223	−0.7004
Panel ADF-statistic	−1.8720**	−2.9240***
Alternative hypothesis: Individual AR coefficients (between-dimension)		
Group rho-statistic	4.1157	
Group PP-statistic	−0.7107	
Group ADF-statistic	−2.8724***	
II. Kao Residual Cointegration Test		
ADF test	−4.8782***	
III. Johansen Fisher Panel Cointegration Test		
Hypothesized # of CEs	Fisher Statistic from Trace Test	Fisher Statistic from Max. Eigenvalue Test
None	129.9***	129.9***
At most 1	324.2***	278.8***
At most 2	121.0***	88.66***
At most 3	97.51***	97.51***

Note:

1. *** and ** denote respectively statistical significance at the one-, and five-percent levels.

potentially exist and hence we proceed with the cointegration estimation. Perhaps it should be stressed, however, that some studies, for example *Wagner* and *Hlouskova* (2010), have found that most of these tests have very low power in many cases and they are unreliable in finding out the correct cointegration relationship.

For simplicity, we assume a homogeneous cointegration relationship for all countries in our sample. We adopt two commonly used basic approaches in the literature to estimate the single cointegrating vector of long-run coefficients. The first approach is the fully-modified OLS (FMOLS) proposed by *Phillips* and *Moon* (1999) and *Pedroni* (2000), whereas the second approach is the dynamic

OLS (DOLS) put forward by *Kao* and *Chiang* (2001) and *Mark* and *Sul* (2003). The estimation results are tabulated as Table 7, in which the first five columns report the FMOLS results and the remaining columns report the DOLS results. In both cases, a constant (level) is specified in the deterministic trend specification to handle the fixed effect.

The first column reports the standard FMOLS results on the pooled sample with the long-run covariances estimated from a Barlett kernel function and the Newey-West fixed bandwidth method. The first stage regression assumes homogeneous long-run coefficients. The second column reports the results following the same procedures except that the first-stage long-run coefficients are allowed to be heterogeneous. As can be clearly seen, the two sets of results are, qualitatively speaking, virtually the same with all variables having the correct signs as predicted by the theory and statistically significant – whether the coefficient variance matrix is estimated from a moment estimator with homogeneous variances or a sandwich method with heterogeneous variances. The parameter estimates are also reasonable and plausible in terms of magnitude – the saving coefficient is about 0.7, whereas those for change in money supply and change in domestic credit creation are about –0.10 and 0.20 respectively. With an adjusted R^2 of 0.82, the specification appears to explain quite well the long-run relationships between investment on the one hand and domestic saving and the monetary factors on the other.

The next three columns still report the results using FMOLS. The weighted FMOLS allows for heterogeneous cointegrated panels with different long-run variances across countries. As in the above case, the two sets of weighted FMOLS assume respectively homogeneous and heterogeneous first-stage long-run coefficients. The group-mean FMOLS offers consistent estimates of the sample mean of the cointegrating vectors in the presence of heterogeneity in the cointegrating relationships (*Pedroni* 2000). As the findings are qualitatively similar to those of FMOLS reported earlier, we do not go into the detailed descriptions here. They serve to give us a rough idea about the sensitivity of the long-run relationship to changes in the underlying assumptions of the model specification. In our case, it may be fair to say that our empirical findings seem to be quite robust, at least qualitatively.

The remaining columns in Table 7 report the results based on DOLS. Columns 6–8 report the results of the DOLS, weighted DOLS and group-mean DOLS respectively. More accurately, they are the static OLS estimation results in these cases because no leads and lags are specified in the estimation procedures. It is perhaps not surprising to observe that the findings are highly similar to the FMOLS results.

Table 7

Results of Panel Cointegration Estimation

Model	*Fully Modified OLS (FMOLS)*				*Dynamic OLS (DLOS)*						
Variable	*Pooled*		*Weighted*		*Group-Mean*	*Pooled*	*Weighted*	*Group-Mean*	*Pooled*	*Weighted*	*Group-Mean*
Saving	0.7177	0.6696	0.756	0.836	0.7462	0.6934	0.7216	0.7204	0.7816	0.8355	0.9454
	(9.71)***	(12.95)***	(12.41)***	(13.72)***	(11.01)***	(9.19)***	(11.51)***	(8.04)***	(9.06)***	(12.10)***	(8.61)***
	[11.11]***	[14.92]***				[7.96]***			[8.91]***		
ΔMoney	−0.1008	−0.1167	−0.0578	−0.3718	−0.2752	−0.1164	−0.0916	−0.2757	−0.131	−0.0897	−0.2118
	(−2.02)**	(−3.34)***	(−0.86)	(−5.54)***	(−5.49)***	(−2.19)**	(−2.39)**	(−3.47)***	(−1.39)†	(−1.28)†	(−1.76)*
	[−2.50]**	[−3.54]***				[−1.98]**			[−1.46]†		
ΔCredit	0.2169	0.2032	0.1108	0.4374	0.3731	0.1589	0.1273	0.3969	0.2014	0.1525	0.3458
	(3.31)***	(4.43)***	(1.92)*	(7.60)***	(6.42)***	(2.43)**	(2.83)***	(4.66)***	(2.04)**	(2.02)**	(2.53)**
	[4.58]***	[4.84]***				[2.45]**			[2.18]**		
Adj. R^2	0.8241	0.8255	0.8222	0.8001	−12.813	0.8313	0.8309	−11.163	0.8777	0.8769	−27.093
S.E.E.	0.0182	0.0181	0.0183	0.0194	0.1513	0.0182	0.0182	0.1545	0.0152	0.0152	0.23

Note:

1. ***, **, * and † denote respectively statistical significance at the one-, five- ten- and twenty-percent levels.
2. Figures in parentheses are t-statistics from the moment estimator (assuming homogeneous variances).
3. Figures in brackets are t-statistics from the sandwich method (assuming heterogeneous variances).

The last three columns of Table 7 report the results of the DOLS, weighted DOLS and group-mean DOLS respectively with the leads and lags in the estimation procedures chosen based on the Akaike information criterion.[10] In this case, the findings are somewhat different from those of FMOLS and static OLS. In particular, the saving coefficient is found to be higher whereas change in money supply become only marginally significant, statistically speaking, at best. It has been noted and pointed out that in many applications the estimator can perform poorly in small samples where the number of time periods is less than 20. This may be a plausible explanation for the discrepancy in our empirical findings.

Overall, the above panel cointegration estimation results are suggestive rather than definitive because, as *Pesaran* (2015a) has correctly pointed out, cointegration in panels is still at an early stage of development. From both a theoretical point of view and the voluminous empirical results in the literature, it is indisputable that there is a long-run relationship between saving and investment. Nonetheless, the above results also suggest that it would probably be a mistake to omit the monetary factors from the long-run relationship for doing so would lead to bias in the saving-investment coefficient.

IV. Conclusion

This study has re-examined the Feldstein-Horioka puzzle by considering explicitly the role of monetary factors in the saving-investment nexus. By integrating the national income and balance-of payments accounting identities, we show that investment is theoretically related to not only domestic saving and international capital flows but also changes in money supply and in domestic credit creation. The latter two monetary factors are largely downplayed or even omitted by the original study of *Feldstein* and *Horioka* (1980) and the huge volume of subsequent studies in the literature.

Empirically, we employ a sample of 20 OECD countries over the period 1960 – 74, as in the original Feldstein-Horioka study, for the purpose of not only verifying our hypothesis but also comparing our findings with those of Feldstein and Horioka. The results of the traditional or classical panel regressions based on fixed-effects specification reveal that both changes in money supply and in domestic credit creation have the correct signs as predicted and are also statistically significant in the saving-investment nexus. The panel cointegration estimation also show a similar long-run relationship between domestic investment, domestic saving and these two monetary factors. In most cases of our regression

[10] The empirical findings remain qualitatively unaffected when the Schwarz or Hannan-Quinn criterion is used instead.

results, the saving-investment correlation is about 0.7 and in one case for a subsample of G-10 countries it is even below 0.5, much lower than the Feldstein-Horioka's original finding of 0.89. The discrepancy between our findings and the Feldstein-Horioka results can be partly explained by their omission of the monetary factors. Although our findings suggest a higher degree of international capital mobility than Feldstein-Horioka's finding, domestic saving in these OECD countries still had a high degree of home bias during the period under study.

Admittedly our empirical results are by no means definitive because of the small sample size and the econometric methods used. We leave the use of large sample and application of more advanced econometric techniques for future research. It suffices for the purpose of this paper to demonstrate that the monetary factors have been omitted from the original Feldstein-Horioka study and also subsequent studies.

While we have not resolved the Feldstein-Horioka puzzle once and for all, we have learned at least some lessons from this exercise. First, we have demonstrated both theoretically and empirically that the monetary factors play an important role in the saving-investment nexus. Money is important in affecting international capital mobility, at least in the short run when the economy is not in full equilibrium. Therefore, we should take money seriously in our future research to resolve the Feldstein-Horioka puzzle.

Second, institutional arrangements also play a crucial role in macroeconomic analysis. The fixed exchange-rate regime during the period under study suggests the applicability of the balance-of-payments identities according to the monetary approach to the balance of payments. As a result of the application, the domestic money supply and credit creation are explicitly shown to be important determinants of international capital mobility.

Last but not least, knowledge of the history of economics also matters. As *Laidler* correctly points out: "Monetary economics has made progress over the years, but not in any easily mapped fashion. It has moved in fits and starts along a path with many detours. Along the way, it has often discovered excellent and powerful ideas, but it has almost often mislaid others which are just as useful." (1990, x) More than two hundred years ago, the great classical writers like David Hume and Henry Thornton already recognized the important role of money in the loanable funds theory and in international capital mobility as well. It is most likely unwise for modern macroeconomists to forget the classical doctrine and not to take money seriously in analysing the saving-investment nexus.

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Data appendix

1. Data sources:

i. Global Financial Development database of the World Bank,
ii. *International Financial Statistics*, International Monetary Fund, and
iii. *OECD National Accounts,* Paris: OECD, various issues.

2. Variable construction:

i. The dependent variable Investment is Ratio of Gross Investment to GDP, where Gross Investment is computed as the sum of capital stock and capital formation. Data are computed from the *OECD National Accounts* database.
ii. The independent variable Saving is Ratio of Domestic Saving to GDP, where Domestic Saving is the sum of net saving and consumption of fixed capital. Data are computed from the *OECD National Accounts* database.
iii. Whenever available, data on Change in Money Supply are calculated from changes in Broad Money as Percentage of GDP from the Global Financial Development database of the World Bank. For some European countries and for some years, such data are not available. These countries include Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Spain and Switzerland. In these cases, we compute Broad Money as the sum of Money and Quasi Money, or as the sum of Currency, Demand Deposits and Other Deposits, and then compute the ratios and changes accordingly. Data are from the *International Financial Statistics* database of the International Monetary Fund.

iv. Data on Change in Domestic Credit Creation are calculated from changes in Domestic Credit to Private Sector as Percentage of GDP from the Global Financial Development database of the World Bank.

3. Countries included in the samples:

Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, United Kingdom and the United States. These are the original 21 OECD countries except Luxembourg, which is usually excluded as an outlier by many studies. This is known as the Luxembourg problem in the literature. See for example *Jansen* (2000) for details.