EUROPEAN UNIVERSITY INSTITUTE
DEPARTMENT OF ECONOMICS

EUI Working Paper **ECO** No. 98/30

# Long Run Capital Flows and the Feldstein-Horioka Puzzle: A New Measure of International Capital Mobility and Some Historical Evidence from Great Britain and the United States

Mathias Hoffmann

**BADIA FIESOLANA, SAN DOMENICO (FI)**

All rights reserved.
No part of this paper may be reproduced in any form
without permission of the author.

©1998 Mathias Hoffmann
Printed in Italy in October 1998
European University Institute
Badia Fiesolana
I-50016 San Domenico (FI)
Italy

# Long Run Capital Flows and the Feldstein-Horioka Puzzle: A New Measure of International Capital Mobility and Some Historical Evidence from Great Britain and the United States

Mathias Hoffmann[1]
Department of Economics
European University Institute
50016 San Domenico di Fiesole (FI)
Italy
email: hoffmann@datacomm.iue.it

September, 30th 1998

[1]I should like to thank Mike Artis and Søren Johansen for insightful discussions and helpful comments. Søren Johansen's note 'What is a positive relation?' has inspired this work. Andrew Rose and Christian Upper have commented on precursors of the paper. I am very grateful to both of them. I would also like to thank seminar participants at UC Berkeley, in particular Petra Geraats who provided a very detailed and extremely helpful written comment. Any remaining errors are of course mine.

**Abstract**

In intertemporal optimization models of current account dynamics, the budget constraint will induce high degrees of positive comovement in the levels of savings and investment and the two variables are likely to be cointegrated. Error correction will then also influence the correlations of the cyclical components which are *per se* uninformative about capital mobility.

As an alternative we suggest a new composite measure of the overall degree of long-run capital mobility based on Johansen's (1988) procedure. We apply our method to historical British and US data and find surprisingly high levels of long-run capital mobility throughout the century.

**Keywords**: International Capital Mobility, Feldstein-Horioka Puzzle, Intertemporal approach to the Current Account, Cointegration, Permanent-Transitory (P-T) Decompositions

**JEL Classification numbers:** C32, F21, F32

# 1 Introduction

In a world with perfect capital mobility, a country can always run current account deficits if its desire to consume and invest cannot be funded domestically. This basic insight provided the motivation for the seminal paper by Feldstein and Horioka (1980) in which the authors found very high savings-investment correlations for a large cross-section of countries. Their result has long been perceived as a puzzle and constitutes a challenge to the view that world capital markets are well integrated. In the presence of perfect capital mobility, investment should go where it yields the highest real returns, whilst consumption should depend only on the permanent value of income, not on contemporaneous investment decisions.

Subsequent research has rationalized the comovement of domestic saving and investment even in the presence of perfect capital mobility. Obstfeld (1986, 1995) and Obstfeld and Rogoff (1995) have pointed to two possible mechanisms to generate the observed correlation. In a small open economy, total factor productivity shocks that are sufficiently persistent can create positively correlated impulse responses of savings and investment. This mechanism is also suggested in Mendoza (1991). The second mechanism relies on global shocks that impinge on both savings and investment simultaneously. This is the channel formally explored in Baxter and Crucini (1993).

Both explanations require strong assumptions about the structure of shocks hitting an economy. First of all, shocks have to be rather persistent and a large share of shocks hitting the economy must be explained at an international level (as the current account would indeed react to idiosyncratic shocks).

In the present paper we suggest a rationale of why we should expect to observe a high degree of comovement no matter what the structure of the underlying shocks is, as long as people maximize utility and live in a growing (i.e. non-stationary) economy. Long run values of savings and investment will move one to one. But once we account for the error correction behaviour, short-run dynamics will be perfectly correlated as well.

If high correlations between savings and investment are likely to ensue even if capital mobility is almost perfect, what can we hope to infer from their joint dynamics about international capital mobility? As Coakley, Kulasi and Smith (1998) point out in a recent survey of the literature on the Feldstein-Horioka puzzle, it has become a consensus in the profession that savings-investment correlations are largely uniformative about the degree of capital mobility.

The original work by Feldstein and Horioka (1980) emphasised the high correlation of savings and investment in a cross-section, whereas formal theoretical rationalizations of the correlation - like the ones mentioned before - mainly aim at explaining the time series behaviour of the two variables. Also in the present paper, the analysis will be confined to the time series properties of savings and investment[1]. We will derive these properties from the reduced-form of a simple intertemporal current account model. We will show that under the assumptions of the theory, the joint dynamics of savings and investment is appropriately specifed in the form of a vector error-correction model (VECM). The long-run adjustment coefficients of this error correction model contain a lot of information about capital mobility. In this context, we find it useful to differentiate between two notions of capital mobility: capital inflow- and outflow mobility. But the appropriate specification of savings and investment in terms of a VECM also provides us with a very convenient composite measure of international capital mobility (ICM), a number between zero and one that is based on Johansen's (1988) procedure for estimating the cointegrating space. Hence, even though correlations of savings and investment are uninformative about ICM, inference about the degree of capital mobility is possible from savings and investment data alone.

It is not within the scope of this paper to attempt to survey the

[1]It should be noted however, that a time series-rationalization is in some way more fundamental: if savings and investment move one to one over time in an individual economy and do so for all economies under study, then, of course, the cross-section correlation will be trivially unity as well.

huge literature on the Feldstein-Horioka finding (for a recent survey see Coakley, Kulasi and Smith (1998) or Obstfeld and Rogoff (1995)). There is, however, a recent trend to use vectorautoregressions and cointegration methods to address the topic. As our paper makes use of these techniques, we will briefly summarize some of this research:

Ghosh (1995) has used a model which allows for intertemporal consumption tilting to motivate a VAR that he then uses to derive a desired current account from observed data. He finds that the desired current account tracks the actual current account reasonably well, hence providing evidence in favor of perfect capital mobility. The puzzle, according to Ghosh, however, is in the excessive volatility of the actual current account vis-a-vis the desired current account.

In a recent paper, Moreno (1997) has suggested to interpret the degree of short-run divergence in the impulse responses of savings and investment as a measure of capital mobility.

Taylor and Sarno (1997) used the structural VAR approach pioneered by Blanchard and Quah (1989) to decompose savings and investment into permanent and transitory components. They find that transitory components of UK/US savings and investment are more highly correlated than changes in the permanent components. They claim that this finding is consistent with the presence of frictions in international capital markets. Only if innovations are permanent does investment flow abroad and the link between savings and investment is loosened. If, however, shocks are transitory, then the cost of investing abroad might be too high due to market frictions and a high correlation between saving and investment comes about. However,their results are supportive of the notion that capital mobility has increased in the 1980s: they report short-run correlations between savings and investment for the period 1979-1994 that are significantly lower than for the 1955-1979 period.

The remainder of the paper is organized as follows: section 2 presents a simple model of current account dynamics based on intertemporal optimization. These models were first applied to current account dynamics by Sachs (1981). We use the model here to derive its empirical implications for the joint dynamics of savings and investment. Section 3 discusses the reduced form implications of the model: savings and investment should cointegrate and hence the classical Feldstein-Horioka regression should yield coefficient estimates near unity. Also we demonstrate that any correlation between the transitory parts of savings and investment can ensue and that these correlations *per se* do not contain any information about capital mobility. In Section 4 we suggest two notions of capital mobility: capital inflow and outflow mobility. We propose to interpret the long-run adjustment coefficients of the cointegrated system as indicators of outflow and inflow mobility respectively. Finally, we suggest a composite measure of international capital mobility (ICM) which is easily calculated as a byproduct of Johansen's (1988) procedure for the estimation of the cointegrating space. Section 5 applies our insights to a unique set of long-run historical data from the United Kingdom and the United States. Section 6 concludes.

## 2 Current account models and cointegration

In this section we examine the implications of the intertemporal model of the current account in the spirit of the work by Sachs (1981) or as discussed in Obstfeld and Rogoff (1995). We use a simple variant of the model which considers a small open economy where the world interest rate is fixed at $r$ and utility is quadratic in consumption. In such a model, the current account can be represented as the discounted sum of expected changes in net output:

$$CA_t = -\sum_{i=1} R^i E_t(\Delta NO_{t+i}) \tag{1}$$

Here, net output is defined as gross national product minus government consumption and investment:

$$NO_t = Y_t - I_t - G_t \tag{2}$$

The current account itself is defined as

$$CA_t \equiv [Y_t - I_t - G_t - C_t] + rB_t \tag{3}$$

where the rectangular bracket is just net output minus consumption, i.e. the trade balance, and $rB_t$ denotes interest payments on the stock $B_t$ of outstanding foreign debt (or wealth) of the economy. Finally, $R = \frac{1}{1+r}$ denotes the intertemporal discount factor.

The present-value relationship (1) together with the definition (3) defines a cointegrating relationship that is typical of present-value models: If the stochastic process

$$X_t = [Y_t, I_t, G_t, C_t, rB_t]' \tag{4}$$

consisting of GNP, investment, government and private consumption and international interest rate payments is an $I(1)$-process, then $\Delta NO_t$ will be $I(0)$ and so will be $CA_t$ as the discounted sum of $\Delta NO_t$. Hence, the definition of the current account in (3) defines a cointegrating relationship with cointegrating vector

$$\beta = \begin{bmatrix} 1 & -1 & -1 & -1 & 1 \end{bmatrix}' \tag{5}$$

This result of current account stationarity is very robust with respect to the specification of the intertemporal model. In particular, the assumptions made above about quadratic utility and a fixed world interest rate can be relaxed. As Obstfeld (1995) has discussed, present-value relationships like (1) will arise in much more complicated and richer models. In particular it is our intuition that it would survive in a model setup where there are barriers to capital mobility. After all, the nation's budget constraint has to be respected no matter how mobile or immobile capital is. But it is just the budget constraint together with the assumption that the driving forces of the economy can be reasonably characterized as $I(1)$-processes that induces stationarity of the current account. In the remainder of the paper, we will not revert to this model but rather focus on its reduced form implications.

## 3 The Feldstein-Horioka regresssion

In this section, we derive the implications of current account stationarity for the Feldstein-Horioka puzzle. In particular, we will investigate how far correlations between savings and investment are informative about capital mobility. Our reasoning will be entirely based on the reduced form and will therefore be independent of assumptions about the structure of the underlying economy that have been used in the literature to rationalize the saving-investment correlation.

To make the point, let us first reduce the notational apparatus from the previous section. Define domestic savings as

$$S_t = Y_t - G_t - C_t + rB_t \tag{6}$$

Then, the current account is just the difference between investment and savings at time t:

$$CA_t = S_t - I_t \tag{7}$$

In their seminal paper, Feldstein and Horioka (1980) performed a regression of the form

$$i_t = a + bs_t + u_t \tag{8}$$

where lower case letters denote variables as shares of GDP, i.e.$i = I/Y$ and $s = S/Y$. We will refer to (8) as the "classical" FH regression.

In a more recent paper, Feldstein and Bacchetta (1991) estimated a specification of the form

$$i_t = a + b(i - s) + u_t \tag{9}$$

As Taylor (1996) pointed out, if $i$ and $s$ cointegrate, (9) will be misspecified. He suggested to estimate a univariate error correction model (ECM)

$$\Delta i_t = a^{ECM} + b^{ECM}\Delta s_t + c^{ECM}(s_t - i_t) + v_t \tag{10}$$

He then suggested to interpret the coefficient $b^{ECM}$ as a measure of short-run capital mobility and $c^{ECM}$ as a measure of long-run capital mobility. As we will argue later, the interpretation of $c^{ECM}$ as an indicator of long-run capital mobility will be flawed as long as savings is not found to be weakly exogenous w.r.t. to the parameters of $i$.

For now, we will develop the reduced form implications of the model in section two. We will develop two notions of a positive relation between savings and investment: between the levels of the two processes and the correlation between the suitably extracted transitory components. And we will comment on how informative these correlations are as measures of ICM. Throughout the remainder of the paper, we will deal with savings and investment *rates*, even though we will at times leisurely refer to $i$ and $s$ as 'investment' and 'savings'.

Now suppose, $i_t$ and $s_t$ can be characterized as $I(1)$-processes. Assume there is a VAR-representation of the joint dynamics of investment and savings. Then, because investment and saving cointegrate with cointegrating vector $[1, -1]'$, there will be an error-correction representation of the form:

$$\Gamma(L)\Delta \left[ \begin{array}{c} s_t \\ i_t \end{array} \right] = \left[ \begin{array}{c} \alpha_1 \\ \alpha_2 \end{array} \right] CA_{t-1} + \left[ \begin{array}{c} \varepsilon_{1t} \\ \varepsilon_{2t} \end{array} \right] \tag{11}$$

where $\Gamma(L) = I - \sum_{i=1}^{k} \Gamma_i L^i$ is a $2 \times 2$–matrix polynomial in the lag-operator $L$ , $\varepsilon_{1t}$ and $\varepsilon_{2t}$ are white-noise disturbances and $\Delta$ is the difference operator.

From the cointegrating relationship (7), we can immediately see that there will be a long-run positive relationship between investment and saving. This should become even clearer when we take an analytic look at the permanent values of $i_t$ and $s_t$. Define the permanent value of an $I(1)$-process $X_t$ as

$$X_t^P = X_t + \sum E_t(\Delta X_{t+i}) \tag{12}$$

i.e. the permanent value is given as today's value plus the sum of all forecastable changes. It is easy to show (see Proietti (97)) that this definition of a permanent value naturally leads to the Beveridge-Nelson

(1982) decomposition. Then

$$X_t^P = C(1) \sum_{l=1}^{t} \varepsilon_l \tag{13}$$

where $\{\varepsilon_l\}$ is the series of innovations to $X_t$ and $C(1) = \sum C_i$ where the $C_i$ are the coefficients of the moving-average (Wold) representation of $\Delta X_t$. Now choose $X_t = \begin{bmatrix} s_t & i_t \end{bmatrix}'$. It is important to recall that in the case where $X_t$ has an error-correction representation, i.e. where

$$\Gamma(L)\Delta X_t = \alpha\beta' X_{t-1} + \varepsilon_t \tag{14}$$

there is a closed-form solution for the matrix $C(1)$, given by

$$C(1) = \beta_{\perp}(\alpha_{\perp}^{'}\Gamma(1)\beta_{\perp})^{-1}\alpha_{\perp}^{'} \tag{15}$$

(See Johansen (1995)).

In our above model $\alpha = \begin{bmatrix} \alpha_1 & \alpha_2 \end{bmatrix}'$ and $\beta = \begin{bmatrix} 1 & -1 \end{bmatrix}$. Then it is easy to verify that $\alpha_{\perp} = \begin{bmatrix} \alpha_2 & -\alpha_1 \end{bmatrix}'$ and $\beta_{\perp} = \begin{bmatrix} 1 & 1 \end{bmatrix}$. Furthermore, let $\Gamma(1) = \begin{bmatrix} \gamma_{11} & \gamma_{12} \\ \gamma_{21} & \gamma_{22} \end{bmatrix}$.

Then, plugging into our closed-form solution for $C(1)$:

$$\begin{bmatrix} s_t \\ i_t \end{bmatrix}^P = A \begin{bmatrix} \alpha_2 & -\alpha_1 \\ \alpha_2 & -\alpha_1 \end{bmatrix} \sum_{l=0}^{t} \varepsilon_l \tag{16}$$

where $A = 1/\left[(\gamma_{11} + \gamma_{12})\alpha_2 - (\gamma_{21} + \gamma_{22})\alpha_1\right]$. Which in turn implies

$$i_t^P = s_t^P \tag{17}$$

i.e., the permanent parts of savings and investment move together one for one.

Hence, the typical Feldstein-Horioka regression of investment on saving rates is just a cointegrating regression in the sense of Engle and Granger (1987). The OLS-estimator is known to be superconsistent in this case and a regression coefficient of unity just reflects the long-run relationship between savings and investment.

Another notion of a positive relation in this context refers to the comovement of the stationary part of the series after appropriate detrending: how should we expect $i_t - i_t^P$ and $s_t - s_t^P$ to correlate and what can we learn from the correlation of the transitory components?

To derive our results, we draw heavily on work done by Johansen (1997), Proietti (1997) and Granger and Gonzalo (1995). We restate the VECM-representation:

$$\Gamma(L)\Delta X_t = \alpha\beta' X_{t-1} + \varepsilon_t \tag{18}$$

The transitory part of savings and investment is a moving average of reduced-form innovations (Beveridge-Nelson (1981)):

$$\begin{bmatrix} s_t - s_t^P \\ i_t - i_t^P \end{bmatrix} = C^*(L)\varepsilon_t$$

The idea is to approximate the transitory part by a linear combination of the current account. Premultiplying the VECM-representation by $C(1)$ we obtain:

$$C(1)\Gamma(L)\Delta X_t = C(1)\varepsilon_t \tag{19}$$

because $C(1)\alpha = 0$. Integrating yields:

$$C(1)\Gamma(L)X_t = C(1)\sum \varepsilon_l \tag{20}$$

We now have a representation of the permanent component in terms of present and past levels of the process itself. Accordingly, we get for the transitory component:

$$\{I - C(1)\Gamma(L)\}\, X_t = C^*(L)\varepsilon_t \tag{21}$$

Let us now rewrite

$$C(1)\Gamma(L) = C(1)\Gamma(1) + \Delta C(1)\Gamma^*(L)$$

where $\Gamma_i^* = -\sum_{j>i} \Gamma_j$. Then, in the above, we obtain:

$$C^*(L)\varepsilon_t = \{I - C(1)\Gamma(1)\} X_t - C(1)\Gamma^*(L)\Delta X_t \qquad (22)$$

It is worthwhile to contemplate this result for a second. The transitory component is a linear combination of the levels of the process plus some moving average of past changes. Note in particular, that $\{I - C(1)\Gamma(1)\} X_t$ has rank $n - h = 1$. Hence, its components are perfectly correlated, but the correlation can be both positive and negative. It is also important to note that $\{I - C(1)\Gamma(1)\} X_t$ is just a linear combination of the equilibrium error $\beta' X_t = CA_t$. This can be seen from the following representation of the matrix $\{I - C(1)\Gamma(1)\}$ which has been derived by Proietti (1997):

$$I - C(1)\Gamma(1) = (\Gamma(1) + \alpha\beta')^{-1} \alpha \left[\beta' (\Gamma(1) + \alpha\beta')^{-1} \alpha\right]^{-1} \beta' = \psi\beta' \qquad (23)$$

The expression $\{I - C(1)\Gamma(1)\} X_t$ therefore captures the error correction mechanism of the model and we can rewrite:

$$\{I - C(1)\Gamma(1)\} X_t = \psi\beta' X_t = \psi c a_t \qquad (24)$$

For the second expression on the RHS of (22), we can write

$$C(1)\Gamma^*(L)\Delta X_t = \beta_\perp f_t \text{ where } f_t = (\alpha_\perp' \Gamma(1)\beta_\perp)^{-1} \alpha_\perp' \Gamma^*(L)\Delta X_t$$

Here, $f_t$ is a common factor and, since $\beta_\perp = \left[\begin{array}{cc} 1 & 1 \end{array}\right]'$, the components of $C(1)\Gamma^*(L)\Delta X_t$will be perfectly positively correlated.

Hence, equation (22) states that $C^*(L)\varepsilon_t$ can be decomposed into one part which captures the error correction of the model, and another part, given by $C(1)\Gamma^*(L)\Delta X_t$ which is pure short-run dynamics. The short-run dynamics of savings and investment are perfectly positively correlated whereas the error correction dynamics are perfectly correlated but either positively or negatively, With this result in mind, what can we infer about capital mobility from the correlation of the components of $C^*(L)\varepsilon_t$?

We can rewrite the correlation of the components as follows:

$$\begin{aligned}\rho &= corr(\mathbf{e}_1'C^*(L)\varepsilon_t, \mathbf{e}_2'C^*(L)\varepsilon_t) \\ &= \frac{\psi_1\psi_2\sigma_{ca} + \sigma_{ff}}{\left[\left(\psi_1^2\sigma_{ca} + \sigma_{ff}\right)\left(\psi_2^2\sigma_{ca} + \sigma_{ff}\right)\right]^{\frac{1}{2}}}\end{aligned} \tag{25}$$

where $\sigma_{ca}$ and $\sigma_{ff}$ denote the variances of the current account and the common factor $f_t$ respectively, $\psi_1$, $\psi_2$ are the components of the vector $\psi$ and $\mathbf{e}_1$ and $\mathbf{e}_2$ are the first and second unit vectors. Note the absence of the covariance $\sigma_{ca,f}$ of $ca_t = \beta' X_t$ and $f_t$ from the above expression. This comes from the fact that the interaction term containing $\sigma_{caf}$ enters $\rho$ in the following way:

$$(\psi\beta_\perp' + \beta_\perp\psi')\,\sigma_{f,ca}$$

Note however, that $\sigma_{f,ca}$ is scalar and hence

$$\psi\beta_\perp'\sigma_{f,ca} = \psi E(\beta' X_t f_t)\beta_\perp' = \psi E(f' X_t'\beta)\beta_\perp' = 0$$

because of $\psi f_t' = X_t'\beta\beta_\perp' = 0$. The same applies accordingly for the second term.

Hence, we can rewrite $\rho$ as

$$\begin{aligned}\rho &= \rho_{ca}\left[1 + \left(\frac{\psi_1+\psi_2}{\psi_1\psi_2}\right)\frac{\sigma_{ff}}{\sigma_{CA}} + \frac{\sigma_{ff}^2}{\psi_1\psi_2\sigma_{ca}^2}\right]^{-\frac{1}{2}} \\ &\quad + \left[\left(\psi_1\psi_2\frac{\sigma_{ca}}{\sigma_{ff}}\right)^2 + (\psi_1+\psi_2)\frac{\sigma_{ca}}{\sigma_{ff}} + 1\right]^{\frac{1}{2}} \\ &= \left[\rho_{ca}\left(\frac{\psi_1\psi_2\sigma_{ca}}{\sigma_{ff}}\right) + 1\right]\left[\left(\psi_1\psi_2\frac{\sigma_{ca}}{\sigma_{ff}}\right)^2 + (\psi_1+\psi_2)\frac{\sigma_{ca}}{\sigma_{ff}} + 1\right]^{-\frac{1}{2}}\end{aligned} \tag{26}$$

This is a representation of $\rho$ in terms of the ratio of the variances of the current account and the short-run dynamics. The correlation coefficient of the components of $\psi\beta' X_t$ is denoted by $\rho_{ca}$ and it is

$\rho_{ca} = \pm 1$. Whenever $\sigma_{ff}/\sigma_{ca} \longrightarrow \infty$ , we will have $\rho \longrightarrow 1$. Conversely, if $\sigma_{ff}/\sigma_{ca} \longrightarrow 0$, $\rho$ will tend to plus or minus unity. In general, $\rho$ can take any value between plus and minus unity. But note that whenever $\rho_{ca}$ is positive, i.e. $+1$, then $\rho$ itself will be positive. This becomes obvious once we recall that $\rho_{ca}\psi_1\psi_2 > 0$ for all $\psi_1, \psi_2$. Hence, whether or not we observe a positive or negative correlation between the components of $C^*(L)\varepsilon_t$ will depend only on whether the error correction dynamics are perfectly correlated with a positive or with a negative sign and on $\sigma_{ca}/\sigma_{ff}$.

We can now summarize our results and answer the question of how informative correlations between transitory savings and investment components will be:

- The pure short-run dynamics of the transitory part of savings and investment are perfectly positively correlated.
- The error correction part will display negative or positive perfect correlation.
- The correlation of the transitory part of savings and investment, will depend on the relative weight of $\sigma_{ca}/\sigma_{ff}$. The correlation $\rho$ can take any value between plus and minus unity but it will always be positive, whenever the error correction part is positively correlated.
- Hence, correlations of the transitory part of savings and investment alone are uninformative about capital mobility.
- If the error correction dynamics are negatively correlated, then the higher the share of the variance explained by pure short run dynamics, the higher will be the correlations of savings and investment. To the degree that we interpret rich short-run dynamics as indicative of high (short-run) capital mobility, this is a paradoxical result that runs diametrically against the original Feldstein-Horioka intuition.

While the implications of the intertemporal budget constraint for the long-run values of $s$ and $i$ have been recognized in the literature, the implications of error correction for the short-term adjustment of savings and investment have so far been overlooked. We have shown that correlations of the transitory parts are *per se* uninformative because the transitory part is an amalgam of both error correction and pure short run dynamics. The question that arises now is whether investment and savings are entirely uninformative as far as international capital mobility is concerned. We address this issue in the next section.

# 4 Inference on international capital mobility using savings and investment data

As we have shown in the previous section, correlations between savings and investment do not allow us to make an inference about international capital mobility. Yet, Feldstein's and Horioka's argument remains appealing in that savings and investment decisions are dichotomic in a world with perfect capital mobility. Hence, the idea of making an inference about the degree of international capital mobility from saving and investment data alone remains tempting.

In this paper we focus on developing the reduced-form implications of the dichotomic savings-investment decisions. As we have shown, the economic model does not have implications for the correlations. Rather, our argument is similar to the one put forward in Taylor (1996). Recall equation (10):

$$\Delta i_t = a^{ECM} + b^{ECM}\Delta s_t + c^{ECM}(s_t - i_t) + v_t \tag{27}$$

Taylor has argued that the adjustment coefficient $c^{ECM}$ captures the reaction of changes in investment to the budget constraint. If capital is very mobile, this coefficient should be low, as the country would have to revert to its budget constraint only in the long-run. This line of argument is very similar to ours. However, we will find it useful to differentiate between two different types of capital mobility, one which we will refer to as capital outflow mobility and another one which we will call capital inflow mobility. Capital outflow mobility measures the ability of capital to leave the country, i.e. under perfect capital outflow mobility there are no capital controls and economic agents can take their savings out of the country at their discretion. Capital inflow mobility pertains to the fact that foreign capital is able to enter the country without impediments, in particular it implies that investment is not constrained by domestic saving.

Instead of using $c^{ECM}$ as a composite measure of long-run capital mobility, we suggest looking at the adjustment coefficients in the bivariate VECM representation of our savings-investment system, i.e. at $\alpha = \left[ \begin{array}{cc} \alpha_1 & \alpha_2 \end{array} \right]$.

If the first of these coefficients, i.e. $\alpha_1$, is close to zero, capital outflow mobility is high. In this case, past current accounts have only a small impact on present changes in savings, i.e. today's savings decision is relatively independent of the budget constraint and hence savings and investment become dichotomic in the sense implied by Feldstein and Horioka.

To illustrate the notion of capital outflow mobility, consider the case of current account targeting discussed in Artis and Bayoumi (1992). Past current account deficits might incur government action in the sense that the government tends to offset private sector behaviour by increasing public sector savings or by trying to induce the private sector to increase its savings through policy action such as capital controls or monetary policy measures such as higher interest rates. No matter what the details of government action look like, however, in these circumstances one would probably expect a stronger predictive power of past current accounts for today's movements in national savings.

Conversely, high capital inflow mobility is indicated by a small absolute value of $\alpha_2$. If capital inflow mobility is high, then domestic investment opportunites should be exploited, regardless of what the current account, i.e. the country's past savings and investment decisions used to be.

Let us relate our indicators of capital mobility to the one suggested by Taylor (1996): In terms of the parameters of the VECM, Taylor's regression can be interpreted as a conditional model of investment, given savings. Conditioning investment on savings yields

$$\Delta i_t = \omega \Delta s_t + (\alpha_2 - \omega \alpha_1) ca_{t-1} + lagged\ dynamics \tag{28}$$

where $\omega$ is a linear function of the covariance structure of the reduced form errors given by

$$\omega = \Omega_{12}\Omega_{11}^{-1} \text{ and } \Omega = \begin{bmatrix} \Omega_{11} & \Omega_{12} \\ \Omega_{21} & \Omega_{22} \end{bmatrix} = E(\varepsilon_t \varepsilon_t')$$

The coefficient $\omega$ measures short-run capital mobility - it is often referred to as a short-run savings retention coefficient (Taylor (1996)). It is a function of the covariance of the reduced form errors, i.e. those innovations in savings and investment that are unexplained by our model. And as such, for once, a high value of $\omega$ is nothing that we should expect from the theory. Hence, low values of $\omega$ can be interpreted as indicative of high short-run capital mobility: changes in savings do not have high predictive power for contemporaneous changes in investment.

In as far as $\omega$ is interpreted as measure of short-run capital mobility, note that the coeffcient $c^{ECM}$ from equation (10) is a function not only of both coefficients of $\alpha$ but also of short-run capital mobility. Hence, $c^{ECM}$does not tell us anything about how sustainable a country's current account position actually is, and hence is not informative about the true adjustment process. The dynamics of a conditional model like (28) are only appropriately specified if savings is found to be weakly exogenous (e.g. Johansen (1995) ), i.e. $\alpha_1 = 0$.

While the information we gain by looking at $\alpha_1$ and $\alpha_2$ separately is certainly valuable, the focus in the literature on univariate modelling can also be explained in terms of the desire to have a composite measure of capital mobility, inflow and outflow. After all, adjustment coefficients may vary a lot across subperiods and they might tell different stories about inflow and outflow mobility. We will therefore suggest a measure of long-run capital mobility that arises naturally as a function of the parameters of our reduced-form model.

Johansen (1988), (1996) has shown that the estimation of the cointegrating space in a VECM is essentially a generalized eigenvalue problem. The maximum eigenvalue ensuing from the solution of this problem can be given the representation

$$\Lambda = \widehat{\alpha}' \widehat{\Sigma}_{00}^{-1} \widehat{\alpha} \tag{29}$$

where $\widehat{\Sigma}_{00}$ is the estimate of the variance-covariance structure of the first auxiliary regression in the Johansen (1988) procedure. The asymptotic distribution of $\Lambda$ and procedures for the estimation of its covariance have recently been worked out by Hansen and Johansen (1998).

The nice property of $\Lambda$ is that it is always between zero and one. Our argument here is that a high level of $\Lambda$ implies low capital mobility whereas a low level of $\Lambda$ is tantamount to a high level of capital mobility. Note in particular, that once $\Lambda$ is zero this implies that the system has two cointegrating relationships, hence $s$ and $i$ are difference stationary but do not cointegrate. But this is exactly what we meant to imply previously: under perfect capital mobility, the system should still revert to equilibrium, i.e. cointegration and error correction should be present but should not be very strong. And this just implies a small (but significant) $\Lambda$. Based on this fundamental insight, we suggest the following statistic as a composite measure of international capital mobility:

$$ICM = 1 - \widehat{\alpha}' \widehat{\Sigma}_{00}^{-1} \widehat{\alpha} \tag{30}$$

We now have two measures of international capital mobility: one, the short-run retention coefficient is nothing else than the correlation between the reduced form errors and tells us how investment and savings are correlated *net* of the working of the intertemporal model. The other one, based on the generalized eigenvalue problem underlying the estimation of a cointegrated system, is a composite measure of how sustainable a country's current account position is and, as such, measures long-run mobility.

Before we apply our insights to long-run historical data from the UK and the United States, let us address an interesting side issue:

Our framework enables us to perform tests of weak exogeneity on both savings and investment. As is shown in Johansen (1996) inter al. weak exogeneityof the $i$-th variable in the system holds only when $\alpha_i = 0$. Tests on the hypothesis that $\alpha_i = 0$ can be performed easily. In particular, once the cointegrating vector is known, we are dealing with a model that is entirely in the stationary domain. The test of $H_0 : \alpha_i = 0, i = 1, 2$ will therefore be asymptotically $\chi^2$-distributed. If we find that one of the variables is indeed weakly exogenous, this has important implications for the interpretation of the transitory and permanent shocks hitting the system:

Assume that we find investment to be weakly exogenous, i.e. $\alpha' = \begin{bmatrix} \alpha_1 & 0 \end{bmatrix}$. Then recall from the representation of the matrix $C(1) = \beta_\perp(\alpha'_\perp\Gamma(1)\beta_\perp)^{-1}\alpha'_\perp$ that the stochastic trends of the system are given by $\alpha'_\perp \sum \varepsilon_t$. But by our assumption on $\alpha$ we have that $\alpha'_\perp = \begin{bmatrix} 0 & 1 \end{bmatrix}$. Hence, the innovations to investment drive the stochastic trend. In other words: permanent shocks in this model *are* investment shocks.

In this sense, our model gives a nice answer to an important question: what is the driving variable behind current account dynamics? Is it investment, or is it savings? We are also going to provide evidence on this issue in the next section that applies our insights to a unique data set due to Taylor (1996).

# 5 Data and Estimation Results

## 5.1 Data, pretests and model parameterization

In this study we use a unique set of long-range annual data on national savings and investment rates compiled and first used by Taylor (1996) to study the topic of international capital mobility. Data for the United Kingdom range from 1850-1992, data for the United States is from 1874 to 1992. Figures 1 and 2 provide a plot of the data set for the two countries.

We first estimated an unrestricted VAR with two lags, as was suggested by the Schwarz-, Hannan-Quinn and Akaike criteria. We then performed Johansen's (1988) tests for cointegration. For the United States we found one cointegrating relationship at the 95-percent level, whereas for the UK, neither the trace- nor the maximum eigenvalue tests statistics suggested the presence of a cointegrating relationship. Table 1 gives the results. We suspected that this failure to detect cointegration in such a long data set might well be due to the UK experience during the two world wars with savings and investment rates dropping to the negative. We decided to estimate a version of the model with two dummies corresponding to 1914-18 and 1939-45 respectively. Now both tests indicated cointegration at the 95-percent level.

Based on these test results, we decided to impose one cointegrating relationship in our estimation procedure. Table 2 gives the estimated cointegrating vectors for both countries. Tests of the hypothesis $\beta' = \begin{bmatrix} 1 & -1 \end{bmatrix}$ yielded favourable results. In neither case could we reject the null at the 5-percent significance level (Table 3).

## 5.2 Adjustment coefficients and tests of weak exogeneity

We are now going to present our estimates of the long-run adjustment coefficients $\alpha$. Table 4 gives the results for the UK and the United States respectively. The results refer to the restricted model, i.e. the VECM is estimated with one cointegrating relationship imposed and the cointegrating space is constrained to the span of $\beta' = \begin{bmatrix} 1 & -1 \end{bmatrix}$.

The first row in table 4 gives the results for the whole sample period. Following the approach adopted in Taylor (1996), we also divided the sample into four subperiods, each of which is supposed to have brought about secular changes in international capital mobility:

- the pre-world war I period of the classical gold standard, 1880-1913. As Bayoumi (1990) has claimed this was the one historical period that came closest to the paradigm of perfect capital mobility.

- The interwar period, a period that Taylor (1996) and Obstfeld and Taylor (1996) have found to be one of secular barriers to capital mobility. Taylor (1996) has included the two world wars in this subsample. We do not follow him in this respect but rather restrict ourselves to the period 1919-39. The reason for this is that our measure of capital mobility is based on the predictive power last period's current account has for today's savings and investment decision. During the two world wars, the US was giving immense financial and material aid to the UK. Hence, the UK was running huge current account deficits which were financed mainly from US current account surpluses. These huge and extraordinary government transfers are likely to bias downwards the estimates of $\alpha$ in our method, as neither the US nor the UK are likely to have been concerned with current account deficits in their wartime policy-making. We have experimented with a sample period running from 1914-45 and indeed our intuition was confirmed in that a higher degree of capital mobility than in the pre-world war I period was suggested by our estimates. This result vanished, however, as we restricted the sample period to 1919-39.

- The postwar period up to the breakdown of the Bretton Woods system, 1946-71

- The post Bretton Woods period, 1971-92, stretching to the end of the sample.

It is a striking result that for both countries and across most subperiods we find at least one of the two variables to be weakly exogenous. The role, however, changes between savings and investment. This indicates that in many situations, the classical Feldstein-Horioka regression or a univariate ECM of savings and investment dynamics will represent an invalid step of conditioning. Our results seem to suggest that there is a lot to gain by examining inflow and outflow mobility separately, which is only possible in a system framework.

Taking account of the whole sample period, in both countries investment seems weakly exogenous at conventional significance levels .

Permanent shocks seem to have been shocks to investment. The picture varies over the subperiods, however. In particular, it is interesting to note the results for the pre-WWI one period 1880-1913: here, investment seems weakly exogenous for the U.S. model, but it is saving that drives the dynamics of the system in the UK. This fits in with the general perception of pre world war I Great Britain as the 'financier of the world', running immense current account surpluses to finance overseas investment. On the other hand, capital inflow mobility as measured by the coefficient $\alpha_2$ seemed very high in that period for the United States. The result prevails equally strongly in both the restricted and the unrestricted models.

For both countries the pre-WWI adjustment coefficients seem smaller than in any other subperiod. In the UK-model it is even not possible to distinguish at a, say, 95%-level between savings and investment as an exogenous stochastic trend (of course, in a cointegrated model, $\alpha_1$ and $\alpha_2$ cannot be zero at the same time, but in the restricted model there is nothing to prevent us from getting this contradicting test result).

In the UK case, capital inflow and outflow mobility remain high in the interwar period whereas for the U.S savings appear weakly exogeneous and adjustment coeffcients are overall higher than in the pre-WWI period.

Overall we find that the role of savings and investment as driving forces of current account dynamics changes over the subperiods. What stands out, however, is that for both countries we find investment to be weakly exogenous for the whole sample period, indicating a high degree of capital inflow mobility. Also, the adjustment coefficients for the period 1880-1913 seem low vis-a-vis later periods, possibly indicating an era of secularly high capital mobility (as suggested in Taylor (1996), *inter al.*). This hypothesis will be further tested in the next section, where we are going to present the results for the composite measure of LR-capital mobility.

## 5.3 Composite ICM

In table 5 we present our results for the composite index of long-run international capital mobility. Over the whole sample period, we find a remarkably high degree of ICM, with point estimates of 0.92 and 0.87 for the UK and the U.S. respectively. Also, the degree of international capital mobility seems precisely estimated, with confidence intervals ranging from 0.8 to 0.93 in the U.S. case and 0.88 to 0.96 for the UK. Taking our measure of ICM seriously, we cannot but state that long-run capital mobility has been almost perfect throughout the century. Again,however, the picture varies a lot across the subperiods.

At the outset, it is interesting to note that for none of the two countries and for none of the subperiods ICM is found to be as high as for the whole sample period. This may seem a little counterintuitive but it is not surprising: first, the subperiods contain few observations. Hence, in many cases, the true degree of international capital mobility is likely to be imprecisely estimated and that is exactly what the standard errors tell us. For many subperiods they are indeed so large that we cannot reject the hypothesis that the degree of ICM in the subperiod considered is equal to the degree measured for the whole sample period. Secondly, our method only allows us to measure capital flows as they have eventually occured. If a country runs persistent deficits in one subperiod, we are likely to underestimate the degree to which the country's current account position is sustainable. Hence, the overall measure of capital mobility, which is nothing else than one minus the appropriately scaled length of the vector $\alpha$ might be biased downwards in a subperiod with persistent current account deficits. On the other hand, current accounts over a long horizon are likely to display sufficient variation in order to speak loudly about the degree of international capital mobility. That is exactly the virtue of using long-run historical data sets as the one we employ here. It is in the light of this reasoning that we should interpret our results for the individual subperiods:

The result for interwar capital mobility in the UK is somewhat surprising as we find ICM to be higher in that period than in the pre-

WWI era. However, given the size of the standard errors, we can not reject equality.

For the United States, our findings are consistent with the results of Eichengreen (1990) and Taylor (1996), who identified the interwar period as an era that was particularly disruptive to international capital mobility. What is surprising however, is that our results suggest that capital mobility continued to fall in the post WWII-era and this for both the UK and the United States. In the case of the United States, only the post-Bretton Wodds period sees levels of ICM that are comparable with those of the classical gold standard.

As our results for the subperiods seem to suffer from small sample bias, we also performed tests for parameter stability as suggested in Hansen and Johansen (1998). Figures 3 and 4 display recursive estimates of $ICM$ and 95-percent confidence intervals for the whole sample period.

For the United States, WWI seems to have been particularly disruptive to ICM. But our estimates suggest that long-run international capital mobility quickly increased after WWI and that already during the great depression, it reached pre-WWI levels. After that, international capital mobility for the U.S. seems to have remained more or less constant over the rest of the sample period, with no major disruptions during the second world war nor further marked increases in ICM in the Bretton Woods or post-Bretton Woods periods.

For the UK before WW-I, we find relatively low levels of long run capital mobility. The variance of the estimate is rather high, though, and indeed, like in the case of the estimation for the individual subperiods, we cannot reject the hypothesis of equality of long-run capital mobility before and after world war one. As in the US case, WWI has disrupted long-run capital mobility severely but in the UK the sustainability of the current account position recovers even quicker than in the United States and stays roughly constant for the rest of the sample period, with the exception of WWII where ICM seems to reach a new peak. Again, we believe that this is due to the exceptional financial aid the UK received from the United States during WWII. Current account deficits have been large in that period but will not have triggered appropriate reactions in savings and investment rates. This will bias the estimates of $\alpha$ downwards.

In spite of high correlations between savings and investment, long-run capital mobility over the century seems to have been remarkably high - at least for the United States and the United Kingdom. The first world war seems to have been disruptive to long run capital mobility but both countries were able to recover long-run sustainable current account positions soon. Our findings suggest that the role of the great depression as a watershed for ICM, as suggested in Eichengreen (1990) and Taylor (1996), is not quite warranted for the two countries. The difference in our results vis-à-vis Eichengreen and Taylor might be due to our exclusive focus on long-run capital flows. The formal setup of our model allows us to distinguish cleanly between the short and the long-run and it seems plausible that the great depression was less disruptive to long-run ICM than to short-run capital flows. As Taylor (1996, p.24) notes:

> 'The findings are fairly consistent with the conventional wisdom: capital mobility has changed little over the long-run, but suffered a setback in the interwar period.'

Given that our results for long-run capital mobility differ somewhat from those reported in the literature, we also set out to estimate short-run capital mobility. After all, our measure of long-run capital mobility is entirely free of short-run dynamics whereas the coefficient $c^{ECM}$ in regression (10) is in fact a function of $\omega$, as the conditional model in (28) shows. Figures 5 and 6 give our recursive estimates of the short-run retention coefficient $\omega$.

The figure gives a striking confirmation of the results of Taylor (1996). The pre-WWI period has seen secularly low saving retention coefficients for both countries. WWI ended this golden age of capital mobility which then recovered quickly in the U.S. case, only to be lastingly disrupted by the great depression. For the UK, short-run capital mobility stays low after WWI and recovers only after the demise of the Bretton Woods system, an event that seems to have had little impact on short-term capital mobility in the United States.

Finally, our findings also suggest that the transition from the Bretton-Woods system to floating exchange rates does seem to have had less impact on long-run international capital flows than is commonly thought. But also for short-run capital mobility, the effects for the two countries in our study were moderate. Only for the UK can an effect be perceived at all. Whereas for neither of the two countries have levels of short-run capital mobility been reached subsequently that are comparable to those that prevailed under the classical gold standard, long-run capital mobility seems to have been relatively high and - with the exception of the WWI-experience - also relatively constant over the whole century.

# 6 Conclusion

In this paper we have investigated in what sense correlations between savings and investment are informative about international capital mobility. We have found that the classical Feldstein-Horioka regression is likely to display a unit coefficient because the intertemporal approach to the current account suggests that savings and investment cointegrate. In as far as correlations between suitably extracted transitory components of savings and investment are concerned, we have shown that the correlation can take any value but that it is uninformative about the degree of capital mobility: rather, the correlation depends on the relative weight of error correction and pure short-run dynamics. Both for themselves will display unit correlations, but the correlation of the components of error correction dynamics can be either positive or negative. Our reasoning demonstrates that time series correlations between savings and investment are *per se* uninformative about the degree of international capital mobility. The findings of Feldstein and Horioka (1980) can therefore be rationalized even when capital mobility is perfect.

Even though this result is not new and has been put forward in the literature, the advantage of our approach is that we derive these conclusions from the reduced-form implications of an intertemporal maximization model. Hence, the results prevail independently of assumptions about the structure of underlying economic shocks. In particular, the implications of error correction for the cyclical dynamics of $s$ and $i$ have to our knowledge not been spelled out.

Still, the suggestion made by Feldstein and Horioka to make inference about international capital mobility from savings and investment data alone remains appealing. After all, the intertemporal maximization model *does* suggest a dichotomy between the savings and investment decision: investments flow where they yield the highest real return, savings depend on the intertemporal consumption decision alone.

In this paper, we have argued that the long-run adjustment process in a cointegrated system is informative about capital mobility . The adjustment coefficients also put us in a position to distinguish between (long-run) capital inflow and outflow mobility. We have also suggested a measure of composite (i.e. inflow&outflow) long run capital mobility that arises naturally in the context of a cointegrated model and can be calculated easily as a byproduct of Johansen's (1988) procedure. The measure has the advantage that it represents a standardized index of international capital mobility that is between zero and one. Also, standard errors of this index can be calculated and hence it becomes possible to compare capital mobility intertemporally and between countries.

Finally, we have applied our insights to a unique data set of historical savings and investment rates for the United States and the United Kingdom.The data are taken from Taylor (1996).

In spite of high correlations between savings and investment, long-run capital mobility over the century seems to have been remarkably high - at least for the United States and the United Kingdom. Also, the effect of the demise of the Bretton Woods system on long-run capital mobility appears low. WWI appears as the major disruption to long-run capital mobility in this century but in both countries long-run sustainable current account positions were restored soon after the war.

Our findings seem somewhat at odds with the literature. But we show that they are due to the fact that our measure of long-run capital mobility focusses exclusively on long-run adjustment. Earlier research has focussed on univariate EC-models where the long-run adjustment coefficient will in general be a function of the true reduced form errors. We have estimated the short-run savings retention coefficient recursively and indeed we could reproduce marvellously the results in the literature:

Present-day ICM is not exceptionally high in a historical perspective. Rather, pre-WWI levels of short-run capital mobility have never since been reached. The interwar period and the great depression seem to have contributed to a decrease in short-run capital mobility that has only partially been offset after the demise of the Bretton Woods system, in the modern era of floating exchange rates.

The original study by Feldstein and Horioka (1980) focussed on cross-sectional rather than on time-series evidence and indeed the cross-sectional evidence seems harder to reconcile with perfect capital mobility than the time-series evidence. On the other hand, a time series model is often more readily interpretable as the reduced form of a formal economic theory. Rather than discussing the pros and cons of cross-sectional versus time-series analysis, in this paper we have chosen to concentrate on the essence of the Feldstein-Horioka approach: the claim that inference on capital mobility is possible from savings and investment data alone. We have demonstrated that this approach is valid even in a time-series study if the appropriate reduced form that is suggested by the theory, i.e. a vector error correction model, is chosen.

# References


[1] Artis, M. J. and Bayoumi, T., (1992), 'Global Capital Market Integration and the Current Account,' in M.P. Taylor (Ed.) *Money and Financial Markets*, Cambridge, MS and Oxford: Blackwell 1992: 297-307.

[2] Bayoumi, T., (1990), 'Saving-Investment Correlations,' *IMF Staff Papers* vol. 37 no. 2:360-87.

[3] Beveridge, S. and Nelson, C. R., (1981), 'A New Approach to the Decomposition of Economic Time Series into Permanent and Tran-

sitory Components with Particular Attention to the Measurement of the Business Cycle,' *Journal of Monetary Economics* 7: 151-74.

[4] Baxter, M. and Crucini, M. J., (1993), 'Explaining saving-investment correlations,' *American EconomicReview* 83: 416-436.

[5] Blanchard, O. and Quah, D., (1989), 'The Dynamic Effects of Demand and Supply Disturbances', *American Economic Review*, 79: 655-73.

[6] Campbell, J. Y, and Shiller, R.J., (1987), ' Cointegration and tests of present value models,' *Journal of Political Economy*, 95: 1062-1088.

[7] Coakley, J., Kulasi, F. and Smith, R., (1998), 'The Feldstein-Horioka Puzzle and Capital Mobility: A Review,' *International Journal of Finance and Economics* 3: 169-188.

[8] Dooley, M., Frankel, J. and Mathieson, (1987), 'International Capital Mobility: What Do Savings-Investment Correlations Tell us?', *Staff Papers of the International Monetary Fund*: 503-530.

[9] Eichengreen, B., (1990), 'Trends and Cycles in Foreign Lending', in H. Siebert (ed.), *Capital Flows in the World Economy*. Tuebingen: Mohr 1990.

[10] Eichengreen, B., (1992), *Golden Fetters*. Oxford: Oxford University Press.

[11] Engle, R. F., Hendry, D.F. and Richard, J.-F., (1983), 'Exogeneity', *Econometrica*, 51, 277-304.

[12] Engle, R. and Granger, C. W., (1987), 'Co-Integration and Error Correction: Representation, Estimation and Testing' *Econometrica*, 55. 251-76.

[13] Feldstein, M. and Horioka, C., (1980), 'Domestic Saving and International Capital Flows', *Economic Journal*, 90, 314-329.

[14] Feldstein, M. and Bacchetta, P., (1991), 'National Savings and International Investment', in Bernheim, B. D. and Shoven, J. B. (eds.): *National Saving and Economic Performance.* Chicago: University of Chicago Press.

[15] Frankel, J. A., (1992), 'Measuring International Capital Mobility: A Review', *American Economic Review Papers and Proceedings*: 197-202.

[16] Ghosh, A., (1995), 'Capital mobility amongst the major industrialized countries: Too little or too much?,' *Economic Journal* 105: 107-128

[17] Glick, R. and Rogoff, K., (1995), 'Global versus country-specific productivity shocks and the current account,' Journal of Monetary Economics

[18] Gonzalo, J. and Granger, C., (1995), 'Estimation of Common Long-Memory Components in Cointegrated Systems,' Journal of Business and Economics Statistics 13: 27-35.

[19] Hansen, H. and Johansen, S., (1998),'Some Tests for Parameter Constancy in Cointegrated VAR-Models', European University Institute mimeo, July 1998.

[20] Johansen, S., (1988), 'Statistical Analysis of Cointegrating Vectors', *Journal of Economic Dynamics and Control*, 12:231-54.

[21] Johansen, S., (1991), 'Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vectorautoregressive models', *Econometrica*, 59: 1551-80

[22] Johansen, S., (1997), 'Common Trends in the Cointegrated VAR-model,' mansucript, European University Institute.

[23] Johansen, S., (1997b),'What is a positive relation?,' manuscript, European University Institute.

[24] Kasa, K., (1992), 'Common stochastic Trends in international stock markets,' *Journal of Monetary Economics* 29: 95-124.

[25] Mendoza, E.G., (1991), 'Real Business Cycles in a Small Open Economy,' *American Economic Review* 81:797-818.

[26] Moreno, R., (1997), 'Saving-Investment Dynamics and Capital Mobility in the US and Japan', *Journal of International Money and Finance*, vol. 16, no. 6: 837-863.

[27] Obstfeld, M., (1986), 'Capital Mobility in the World Economy: theory and measurement', *Carnegie Rochester Conference Series on Public Policy*, vol 24, 55-104.

[28] Obstfeld, M., (1995), 'International Capital Mobility in the 1990s' in Kenen, P. (ed.) *Understanding Interdependence*, Princeton University Press, 1995.

[29] Obstfeld, M. and Rogoff, K. (1995), 'The intertemporal approach to the current account,' NBER working paper 4893.

[30] Proietti, T., (1997), 'Short-Run Dynamics in Cointegrated Systems,' *Oxford Bulletin of Economics and Statistics* 59: 405-422.

[31] Sachs, J, (1981), 'The Current Account and Macroeconomics adjustment in the 1970s,' *Brookings Papers on Economic Activity* 1:201-268.

[32] Sarno, L. and Taylor M. P., (1998), 'Savings-Investment Correlations: transitory versus permanent,' *The Manchester School Supplement* 1998, 17-38.

[33] Taylor, A. M., (1994), 'Domestic Saving and International Capital Flows Reconsidered', NBER Discussion Paper Series, no. 4892.

[34] Taylor, A. M., (1996), 'International Capital Mobility in History: The Saving-Investment Relationship', NBER Discussion Paper Series, no. 5743.

# Figures and Tables

Table 1a: cointegration tests for the US 1874-1992

| | Trace Statistics | Max EV Statistics |
|---|---|---|
| $0 < h \leq 1$ | 22.29 | 16.73 |
| $1 < h \leq 2$ | 5.564 | 5.564 |

Table 1b: cointegration tests for the UK 1850-1992

| | Trace Statistics | Max EV Statistics |
|---|---|---|
| $0 < h \leq 1$ | 13.91 | 11.37 |
| $1 < h \leq 2$ | 2.542 | 2.542 |

Table 1c: UK 1850-92 with dummies for WWI&II

| | Trace Statistics | Max EV Statistics |
|---|---|---|
| $0 < h \leq 1$ | 59.3 | 56.96 |
| $1 < h \leq 2$ | 2.347 | 2.347 |

Table 1d: Critical Values of Cointegration Tests

| | Trace Statistics | | Max EV Statistics | |
|---|---|---|---|---|
| | 90% | 95% | 90% | 95% |
| $0 < h \leq 1$ | 15.58 | 17.84 | 12.78 | 14.6 |
| $1 < h \leq 2$ | 6.69 | 8.803 | 6.69 | 8.083 |

Table 2:
Estimated cointegrating vectors

| | US 1874-1992 | UK 1850-1992 |
|---|---|---|
| $\beta$ | 1 | 1 |
| | $-0.8506$ | $-0.6526$ |

Table 3:
Tests of $H_0 : \beta' = \begin{bmatrix} 1 & -1 \end{bmatrix}$

| | US | UK |
|---|---|---|
| | 1874-1992 | 1850-1992 |
| LR | 3.218 | 1.959 |
| p-value | 0.9271 | 0.8384 |

Table 4: Long-run adjustment coefficients

| | United Kingdom | | United States | |
|---|---|---|---|---|
| Period | $\alpha$ | $p$-value | $\alpha$ | $p$-value |
| 1850/74-1992 | $-0.1594$ | 0.9999 | $-0.2473$ | 1 |
| | $-0.01986$ | 0.5218 | $-0.06767$ | 0.8783 |
| | | 0.9973[1)] | | 0.9995[1)] |
| 1880-1913 | 0.03985 | 0.79 | $-0.1442$ | 0.9976 |
| | 0.07034 | 0.9844 | 0.01017 | 0.1786 |
| | | 0.7715[1)] | | 0.9942[1)] |
| 1919-39 | $-0.1616$ | 0.7891 | 0.08646 | 0.8482 |
| | 0.0275 | 0.4173 | 0.5222 | 1 |
| | | 0.7065[1)] | | 1[1)] |
| 1946-71 | $-0.9133$ | 1 | $-0.38$ | 1 |
| | 0.1173 | 0.6394 | 0.468 | 1 |
| | | 1[1)] | | 1[1)] |
| 1972-1992 | $-0.05154$ | 0.4194 | 0.06675 | 0.6825 |
| | 0.3159 | 0.9672 | 0.2834 | 0.9978 |
| | | 0.9478[1)] | | 0.96[1)] |

[1)] the third p-value pertains to the hypothesis $\alpha_1 = \alpha_2 = 0$

Table 5 Index of International Capital Mobility

| | UK | US |
|---|---|---|
| 1850/74-1992 | 0.9236 | 0.8689 |
| | (0.8795 0.9699) | (0.8047 0.9381) |
| 1880-1913 | 0.6309 | 0.7708 |
| | (0.468 0.8505) | (0.5956 0.9975) |
| 1919-39 | 0.7203 | 0.4931 |
| | (0.5308 0.9774) | (0.285 0.8533) |
| 1946-71 | 0.4907 | 0.105 |
| | (0.3153 0.7636) | (0.04678 0.2357) |
| 1972-92 | 0.7082 | 0.7875 |
| | (0.5138 0.9761) | (0.6234 0.9949) |

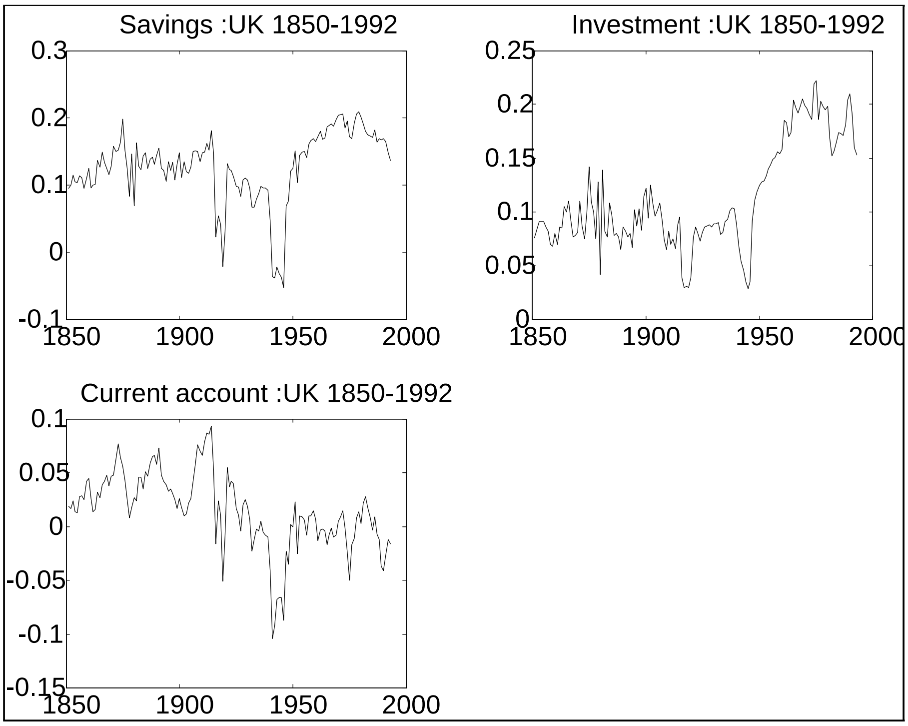


Figure 1: The UK Data 1850-1992

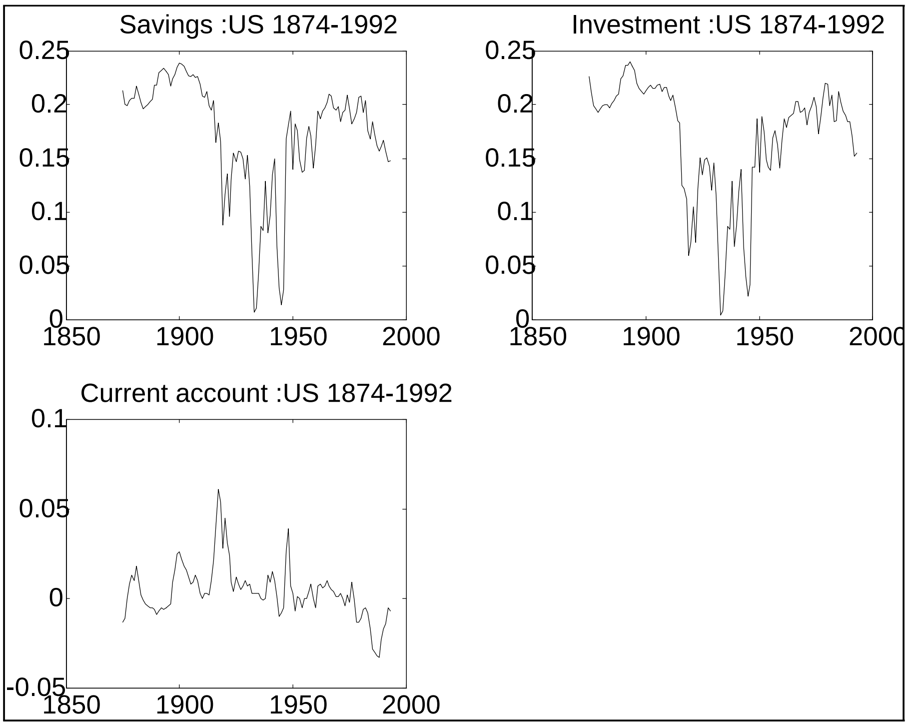


Figure 2: The US Data 1874-1992

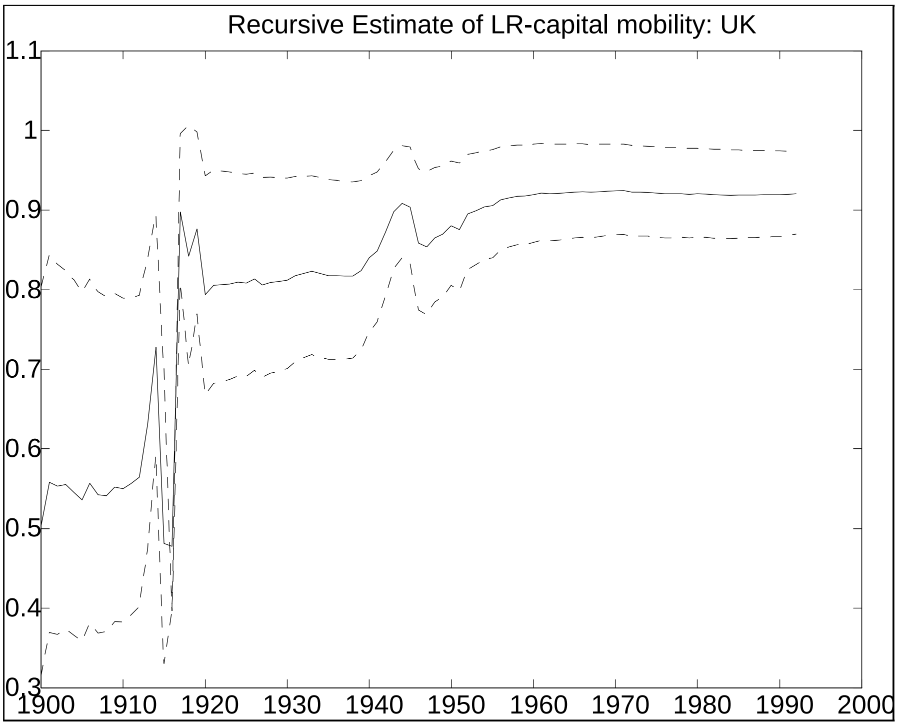


Figure 3: Long run capital Mobility in the UK

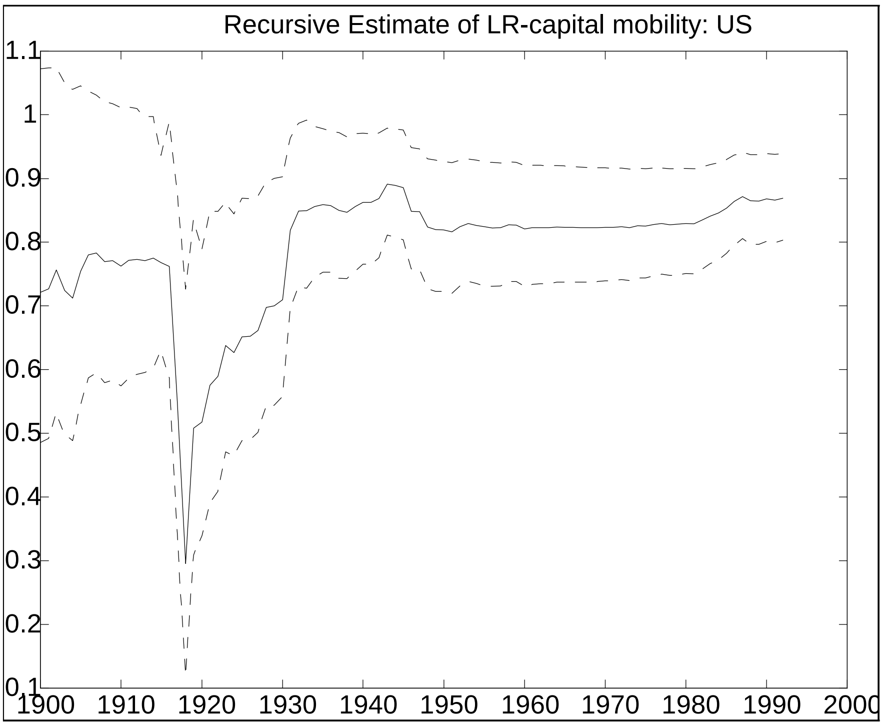


Figure 4: Long run capital mobility in the U.S.


Figure 5: Short run capital mobility in the UK

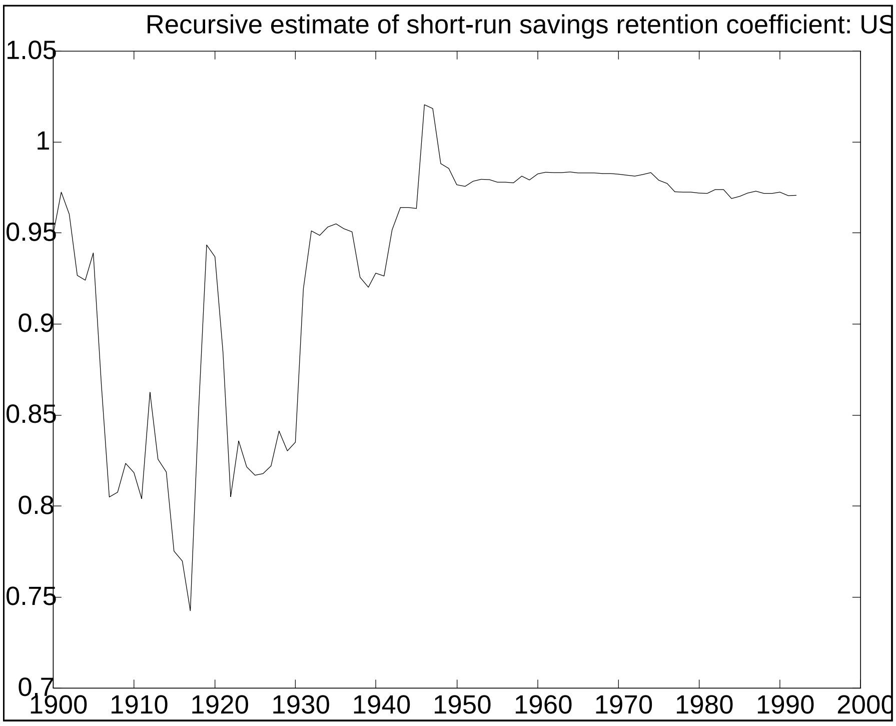


Figure 6: Short run capital mobility in the U.S.