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A CENTURY OF CURRENT ACCOUNT DYNAMICS

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ABSTRACT

Recent globalization trends have refocused attention on the historical evolution of international capital mobility over the long run. The issue is examined here using time-series analysis of current-account dynamics for fifteen countries since circa 1850. The inter-war period emerges as an era of low capital mobility and only recently can we observe a tentative return to the degree of capital mobility witnessed during the late nineteenth century. The analysis of saving and investment dynamics also helps make sense of the frequently observed high correlation of saving and investment rates in historical data.

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1. Introduction

Although economic historians have long been concerned with the evolution of international capital markets over the long run, empirical testing of market integration has been limited. Conventional wisdom suggests that late-nineteenth century markets were relatively well integrated under the classical gold standard centered on London; that the inter-war period was one of disintegration and imperfect capital mobility, especially after 1929; and that the postwar period has been characterized by gradually increasing capital market integration.[1] This paper seeks to confront and test such hypotheses by modeling current-account dynamics.

The evolution of international capital mobility is, in principle, closely tied to the trends and cycles in foreign lending. Yet the presence of flows, is neither a necessary nor sufficient condition for market integration: a small autarkic country with a rate of return no different from the "world" market will exhibit no incipient flows upon opening its capital market. Conversely, countries with substantial barriers to capital mobility may nonetheless experience capital flows of some sort provided international rate-of-return differentials are sufficiently large.

Still, despite shortcomings, a substantial literature has evolved using quantity criteria for evaluating capital mobility. An influential contribution was that of Feldstein and Horioka (FH) (1980) which used data for the 1960s and 1970s on saving and investment rates to assess whether incremental savings were retained in the home country or else entered the global capital market seeking out the highest return. The FH "puzzle" was the surprisingly high correlation of saving and investment, or, put another way, the very small size of current accounts.

Is it really a puzzle? Methodologically, my main contribution is to go beyond the traditional cross-sectional FH test, and to offer an alternative time-series approach based on a more explicit dynamic model. At low frequencies we expect saving and investment to be highly correlated simply because all countries must abide by a long-run version of current account balance in order to satisfy their intertemporal national long-run budget constraint (LRBC).

To give an example, consider a Solovian small-open economy with initial capital scarcity (capital-labor ratio below steady-state level for a given world interest rate) and with a zero rate of deterministic exogenous growth. Suppose there are installation costs of capital (or other frictions) that prevent instantaneous adjustment to a steady-state capital stock. The economy will borrow to invest and will also borrow to consumption-smooth given its level of permanent income. Saving will be low, and investment high, at first. But in the long run investment will settle down to a replacement level as capital approaches its steady-state value, and saving will settle down to a positive level to offset earlier loans. The current account will reach an equilibrium, whereby the interest due on debt each period is serviced by a trade surplus. In steady state, with zero exogenous growth, all real variables are fixed in levels, so the debt is constant, and hence the equilibrium current account (the change in debt each period) is zero.

[1] See Obstfeld and Taylor (1998, 2002).

We can show that the precise international finance model is not important here. The above insight about the LRBC extends to models with non-zero growth and models of growth with stochastic shocks. Whatever the model, the LRBC is always invoked as a key axiom. Can we test whether it holds? And what does that imply for the dynamics of the system? Saving and investment may, in general, have trends or unit roots; but it can be shown that a *sufficient condition* for the LRBC to hold is that the current account be stationary, requiring that investment and saving will be cointegrated. Hence, a vector error-correction model (VECM) emerges as a natural theoretical framework, where shocks to saving and investment can be modeled in the context of a long-run equilibrium relationship between the two. [2]

In this paper I develop an applied LRBC framework for studying current-account dynamics as a tool for assessing capital mobility in a comparative historical setting. Reassuringly, the empirical results applied to the actual data from the last century tell a story consistent with the stylized facts. I also find that the results can make sense of the common FH finding, since the "high" correlation of saving and investment emerges as a natural implication of the LRBC approach.

The results tell us something of interest about the changing degree of integration in global capital markets over time. Since our focus is the LRBC condition, our empirical approach is designed to reveal the changing ability of economies to employ net capital inflows and outflows to escape closed-economy saving-investment constraints. Of course, this is not the only feature of globalized capital markets, and a single parameter cannot adequately summarize the various aspects of market integration. A battery of other test on gross capital flows, interest parity, and arbitrage costs would round out a more complete picture. Though such tests are beyond the scope of this paper, it suffices to note that they deliver results very consistent with the picture presented here. [3]

2. LRBC and current account dynamics

The theory of the LRBC is well-developed and need not be repeated here in full. We will be applying it at the level of the national economy, following earlier studies like Trehan and Walsh (1991), Hakkio and Rush (1991), and Wickens and Uctum (1993). A brief survey now follows.

Some basic definitions and notation will prove useful. Define gross domestic product Q as the sum of goods produced, which, with imports M, may be allocated to private consumption C, public consumption G, investment I, or export X, so that $Q + M = C + I + G + X$. Rearranging, GDP is given by GDP $\equiv Q = C + I + G + NX$, where $NX = X - M$ is net exports. If the country's net credit (debt) position vis-à-vis the rest of the world is B ($-B$), and these claims (debts)

[2] See Jansen (1996); Jansen and Schulze (1996); Miller (1988); Vikøren (1991).

[3] It is debatable whether capital mobility is better measured using models of gross or net capital movement. Gross flows may reflect integration due to "diversification finance" and net flows integration due to "development finance"—but the two appear to be often unrelated (Obstfeld and Taylor 2002).

earn (pay) interest at a world interest rate r, then gross national product is GDP plus (minus) this net factor income from (to) the rest of the world, GNP $\equiv Y = Q + rB = C + I + G + NX + rB$.

It is then straightforward to show that the net balance on the current account CA satisfies $CA \equiv NX + rB = (Y - C - G) - I = S - I$, where $S \equiv Y - C - G$ is gross national saving. Finally, the dynamic structure of the current account and the credit position is given by the equality of the current account (CA) and the capital account (KA), with $B_t - B_{t-1} \equiv KA_t = CA_t$.

2..1 An economy with zero growth and stochastic shocks

Let us now make the theory of the LRBC concrete. Consider, for example, the deterministic zero-growth Solovian economy mentioned in the introduction. In steady state, real variables like output Q, income Y, consumption C, capital stock K, assets B, exports X, imports M, and trade balance NX, all grow at the zero steady-state rate. Thus, the current account must be zero in steady state, with $0 = B_t - B_{t-1} = CA_t$. Hence, in steady state, $0 = NX + rB$, or $NX = -rB$, and trade surpluses (deficits) exactly offset interest payments (income) each period.

Is there a way to develop an econometric test of the LRBC suited to a situation like this? Can it apply even to stochastic settings? Indeed, yes. We know that, when the interest rate is not constant,

$$B_t - B_{t-1} = r_t B_{t-1} + NX_t. \tag{1}$$

Here, change in credit position equals interest on assets plus the current period's trade surplus. Following Trehan and Walsh (1991, p. 209), we may iterate this equation forward in time, solving recursively, to obtain the result that the current credit (debt) position must be offset, in expected value, by future deficits (surpluses). Let $R_t = 1 + r_t$ with expected value $E(R_{t+i}|I_{t-1}) = R$ for all t and $i \geq 0$, and let I_t be the information of private agents at time t. We can then write

$$B_{t-1} = -\sum_{j=0}^{\infty} R^{-(j+1)} E(NX_{t+j}|I_{t-1}) + \lim_{j\to\infty} R^{-(j+1)} E(B_{t+j}|I_{t-1}). \tag{2}$$

We define the LRBC hypothesis to be that the last term in 2 must equal zero,

$$\text{LRBC}: \lim_{j\to\infty} R^{-(j+1)} E(B_{t+j}|I_{t-1}) = 0, \tag{3}$$

which states that the present discounted value of the stock of assets must converge to zero as t tends to infinity.

The key result establishes a sufficient condition for equation 3 to hold:

Proposition 1 *If R_t is a stochastic process strictly bounded below by $1 + \delta$ ($\delta > 0$) in expected value and $CA_t = B_t - B_{t-1}$ is a stationary process, then LRBC holds.* [4]

[4] Consult Trehan and Walsh (1991, pp. 209–15) for details of the proof.

Note that this test applies to *any* model with an LRBC axiom. It clearly applies to all deterministic models. It also allows for stochastic wealth shocks to that may redistribute wealth across countries, since such shocks are absorbed in the R_t term (where national net wealth is affected by shocks to the net foreign asset position). We thus have in this proposition a powerful tool for testing a fundamental assumption of international macroeconomic models.

2..2 An economy with positive growth and stochastic shocks

Given that I will implement these tests on data that span two centuries, it is now necessary to see how the theory and testing of the LRBC might change in the presence of long run growth. Surely this must change the econometric implications, and intuitively we expect a less-stringent constraint to be relevant. After all, an economy may be able to "grow out of debt"—debt may not shrink to zero or even remain constant, but it may grow at a the same steady-state rate slower as the economy. Can we allow for such possibilities in the model and in the empirics?

Consider again the simple Solvian economy. For simplicity, think first about the deterministic case. In the steady state, let the world grow at a growth rate g.[5] In any country, all real variables grow at a rate g also, including income Y, debt B, and the current account CA. Let $\widetilde{X}$ denote X/Y for any real variable X. Thus $\widetilde{B} = B/Y$ and $\widetilde{CA} = CA/Y$ must be constant in the steady state.

We can now admit a stochastic growth process into the world economy, where all economies grow at a growth rate g_t with $G_t = 1 + g_t$, and where $E(g_t) = g > 0$, $E(G_t) = G > 1$. We can easily derive the difference equation for $\widetilde{B}$ from equation 1. Given that $B_t = R_t B_{t-1} + NX_t$, it follows that

$$\widetilde{B}_t = \frac{R_t}{G_t}\widetilde{B}_{t-1} + \widetilde{NX}_t. \tag{4}$$

Hence the above derivations in equations 1–3 can be applied in an analogous set of equations with all variables X replaced by $\widetilde{X}$ and R_t replaced by $\rho_t = R_t/G_t$. Let $\rho = E(\rho_t)$. The iterated budget constraint becomes

$$\widetilde{B}_{t-1} = -\sum_{j=0}^{\infty} \rho^{-(j+1)} E(\widetilde{NX}_{t+j}|I_{t-1}) + \lim_{j\to\infty} \rho^{-(j+1)} E(\widetilde{B}_{t+j}|I_{t-1}), \tag{5}$$

and the new LRBC hypothesis in this context requires the last term to vanish,

$$\text{LRBC}: \lim_{j\to\infty} \rho^{-(j+1)} E(\widetilde{B}_{t+j}|I_{t-1}) = 0. \tag{6}$$

The sufficient condition for equation 6 to hold follows as an immediate corollary of the proposition:

[5] We suppose that all countries grow at a common steady state growth rate so that no single country outgrows the rest of the world economy in the long run—for then that country would be unable to lend or borrow a constant fraction of debt to or from the rest of the world.

Corollary 1 *If $\rho_t = R_t/G_t$ is a stochastic process strictly bounded below by $1+\delta$ ($\delta > 0$) in expected value and CA/Y_t is a stationary process, then LRBC holds.*
Note that the requirement that $E(\rho_t)$ be strictly bounded away from unity can be viewed as the stochastic equivalent of the condition that the economy be dynamically efficient, and in the deterministic case it is evidently equivalent to the condition $0 < g < r$. In what follows, this condition will be assumed to hold.

3. Capital flows and the LRBC in two centuries

It is the modified version of the LRBC test that we will use next to see if countries have obeyed their LRBC over the very long run using over 100 years of time series data for a cross-country sample. I now introduce the basic data to be used in this study. I collected information on saving ratios S/Y, investment ratios I/Y, and current account ratios CA/Y for 15 countries covering approximately the period 1870 to the present. The countries in question are Argentina, Australia, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Spain, Sweden, the United Kingdom, and the United States. [6] .

Since the current account is central to the analysis it is worth spending a moment to look at the long-run behavior of capital flows in my sample. A sense of the changing patterns of international financial flows can be gleaned by examining their trends and cycles. To permit a normalization we look at CA/Y, the size of the current account balance as a fraction of income.

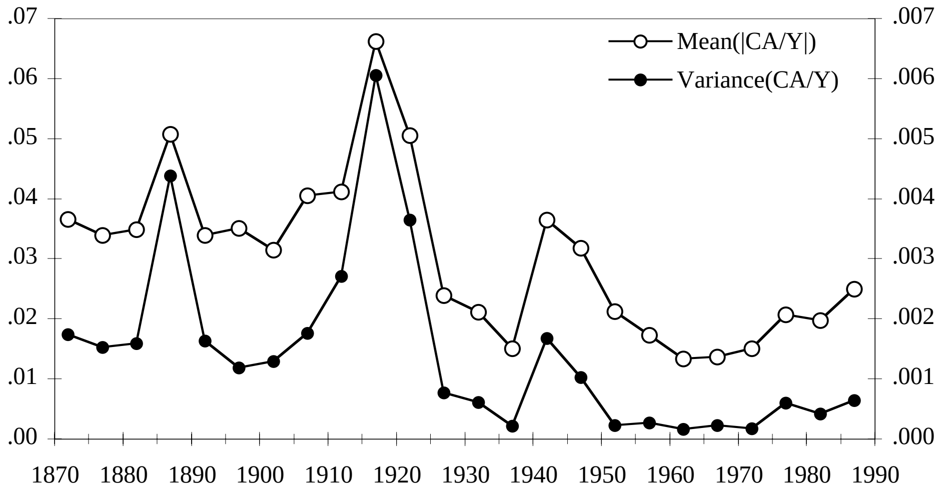
Figure 1 presents the basic trends in foreign capital flows. Two measures of the extent of capital flows are used, both of which measure the cross-sectional dispersion of $(CA/Y)_{it}$ for fixed t, the variance $\sigma^2_{CA/Y,t}$ and the mean absolute value $\mu_{|CA/Y|,t}$. Quinquennially averaged data are used throughout.

Both measures show similar patterns across time. Consider $\mu_{|CA/Y|}$. The average size of capital flows in this sample was often as high as 4%–5% of national income before World War I. At its first peak it reached 5.1% in the overseas investment boom of the late 1880s. This dropped back to around 3% in the depression of the 1890s. The figure approached 4% again in 1905–14, and wartime lending pushed the figure over 6% in 1915–19. Flows diminished in size in the 1920s, however, and international capital flows were less than 2% of national income in the late 1930s. Again, wartime loans raised the figure in the 1940s, but in the 1950s and 1960s, the size of international capital flows in this sample declined to an all time low, around 1.3% of national income. Only in the late 1970s and 1980s have flows increased, though not to levels comparable to those of a century ago.

Flow data, as a quantity criterion, serve only as weak evidence of changing market integration. However, the data offer *prima facie* evidence that the globalization of the capital market has been subject to major dislocations, most notably the inter-war period, with a dramatic contraction of flows seen in the Depression of the 1930s. Moreover, this low level in the volume of flows persisted long into the postwar era.

[6] The data are in an appendix available from the author.

Fig. 1. Current account relative to GDP: mean absolute value and variance



Notes and Sources: See text and appendix. Mean absolute value and variance for 15 countries, quinquennial periods.

We now turn to more formal tests to see whether this description, and the conventional historiography of world markets that points to the Depression as an era of disintegration, has broader support. The first important question we ask is whether the data support the LRBC condition by testing for the stationarity of CA/Y (Corollary 1) using the full time dimension of the data, around 100 years in all cases. Table 1 shows the results of applying the augmented Dickey-Fuller test, with a constant but no time trend, to the series S/Y, I/Y, and CA/Y for each country in our data set.[7]

The results show that whereas the saving and investment ratios are nonstationary, the current account-to-GDP ratio is stationary for all countries in the raw data. That is, every country in our sample appears to be obeying its long-run budget constraint in the long sweep of history from the late nineteenth century to the present.

This is not to say that, in some periods, countries were unable to run "unsustainable" current account deficits, which were occasionally disrupted by crisis, real adjustments, or default. Episodes in some countries during the 1890s, 1930s, or 1980s could fit this description, but in the long run analysis we find that such short-run explosive tenedencies have been, in general, too limited in duration or amplitude to cause nonstationarity of debt in the Ponzi sense.

Accordingly, our strategy will be to treat such shocks to creditworthiness, ability to pay, country risk, and so on, as a part of the perturbation dynamics of the system, along with all other real shocks. In modeling we will aim to partition the system's behavior between such perturbations and the endoegnous dynamics. Using this strategy, if the preceding results convince us that these economies have obeyed the LRBC in the long run, we must now consider what that implies for the dynamics

[7] As regards lag selection, the LM test for serial correlation suggested 0 lags in most cases, with 1 lag on only two occasions. The results with 1 lag are similar to those presented here.

Table 1
Unit root tests

Series	S/Y	I/Y	CA/Y	T
Argentina	-2.65*	-1.90	-4.30***	108
Australia	-3.63***	-3.58***	-6.02***	132
Canada	-2.05	-2.32	-2.61*	123
Denmark	-1.91	-1.81	-5.05***	113
Finland	-2.44	-2.18	-4.86***	133
France	-3.39**	-3.71***	-8.31***	134
Germany	-2.50	-4.23***	-5.33***	99
Italy	-3.02**	-3.29**	-3.67***	132
Japan	-1.87	-1.68	-5.03***	107
Netherlands	-4.18***	-2.56	-4.66***	119
Norway	-2.93**	-3.72***	-5.14***	122
Spain	-1.86	-1.31	-5.51***	143
Sweden	-2.33	-2.13	-4.91***	132
United Kingdom	-2.75*	-3.30**	-3.43***	124
United States	-3.76**	-1.25	-3.31***	143

Notes and Sources: See text and appendix. Augmented Dickey-Fuller t-test. No lags, no time trend, constant term in all cases. T is sample size. * denotes significant at 10 percent level, ** at 5 percent level, and *** at 1 percent level,

of the current account, saving, and investment, and how we may interpret the results as a measure of capital mobility.

4. Current account dynamics and capital mobility

It is of interest to do more than just verify that CA/Y is stationary. In fact, the dynamics of CA/Y can tell us a great deal about capital mobility. We can investigate the adjustment speed of CA/Y back towards its equilibrium or steady-state value. To do this I implemented simple AR(1) regressions of the form

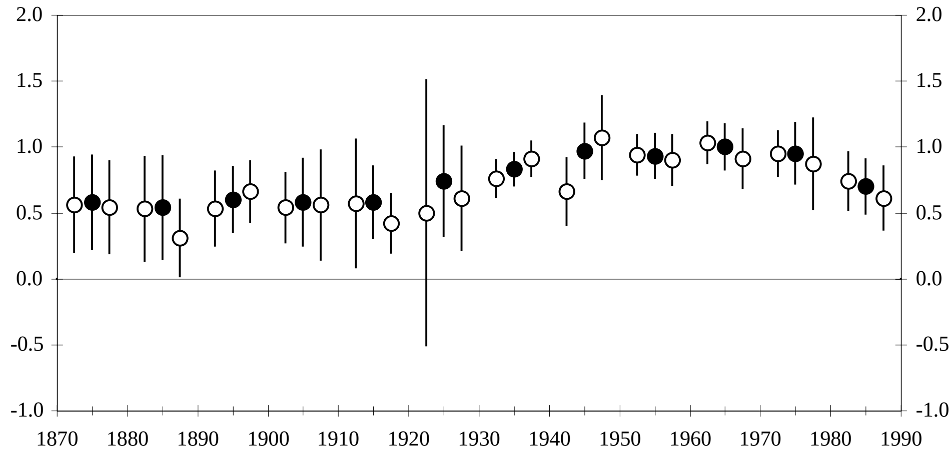
$$\Delta(CA/Y)_t = \alpha + \beta(CA/Y)_{t-1} + \epsilon_t. \tag{7}$$

and examined the convergence speed β and error variance σ^2 in each case. I did this for samples with pooling across space and for each of the 15 individual countries; and for pooling across time as well as for four subperiods.

I find below that the AR(1) model is an adequate and parsimonious specification for these purposes. Using the LM test, higher lag orders are not required so that all the internal dynamics of the model are summarized in the coefficient β, and the shocks ϵ a random and serially uncorrelated (non-persistent). Thus, interpretation of the dynamic model is relatively simple.

How should we interpret the model parameters? If β is small (close to zero) we would infer that the country has a flexible current account and the capacity to run persistent deficits or surpluses. Conversely, if β is high (close to one) the country has a rigid current account where deviations from balance are hard to sustain. In this framework, we might consider the former to be evidence of high capital market

Fig. 2. Feldstein-Horioka estimation: FH coefficient ± 2 standard errors



Notes and Sources: See text and appendix. Quinquennial and decadal samples shown.

mobility as compared to the latter.

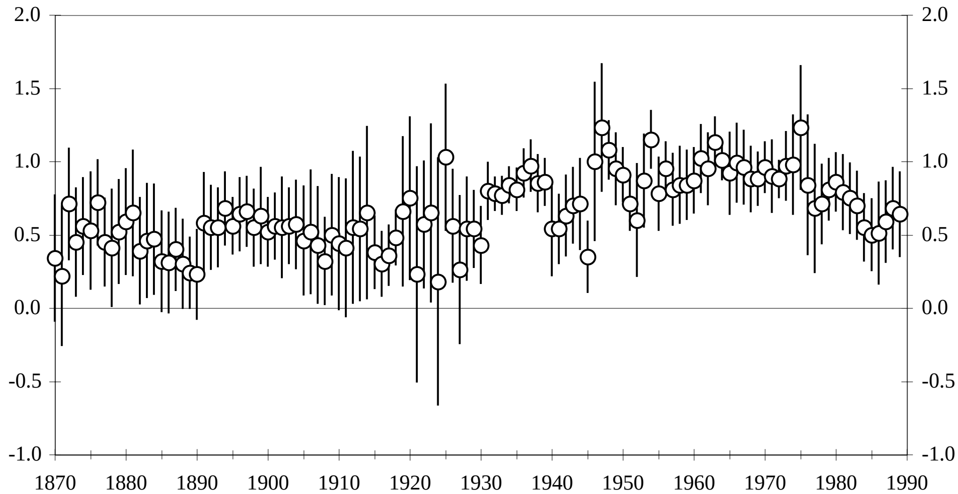
Hence, I take the strong view that β is a summary statistic, derivable from the dynamic processes of saving and investment (which I consider in a moment) and pertaining to the ability of countries to externally smooth shocks to saving and investment. Thus, I consider these parameters to be related to the true, underlying transaction costs that might impede perfect capital mobility—where costs are broadly construed to include distortions and barriers arising from policies, institutions, and underdevelopment that impinge on the efficient workings of external capital markets.

How should we interpret the shocks ϵ_t? These can be construed as real shocks to the open economy resulting from a variety of sources: technology, taste, world interest rates, and so on. These will be considered the forcing terms for the equation, and for the present purposes assumed to be exogenous. If the error variance σ^2 is high, it indicates a large range of real shocks to the current account; a small variance indicates more tranquil times in the external balance.

The parameter β and shocks ϵ_t clearly have a direct bearing on the FH puzzle. Feldstein and Horioka coined the term "savings-retention coefficient" to describe the regression coefficient b in the equations $S/Y = a + b(I/Y) + \epsilon$. Their finding has been replicated many times, so much so as to be now considered a robust result. [8] Obviously, if capital flows are small, the FH coefficient is bound to be close to unity. For illustration, the FH test applied to my panel data produces the results shown in Figures 2 and 3. Figure 2 displays the FH coefficient for both five-year and ten-year

[8] See Feldstein and Bacchetta (1991); Frankel (1991); Obstfeld (1986, 1994); Tesar (1991); Sinn (1992). For historical analyses see Bayoumi (1989); Zevin (1992); Eichengreen (1990). Of the latter, none uses as wide a sample of countries as I have here.

Fig. 3. Sinn’s cross-section coefficient ± 2 standard errors



Notes and Sources: See text and appendix.

averaged data. Figure 3 shows Sinn’s (1992) coefficient for annual data.[9]

Now that we have a dynamic AR(1) model of the current account, we see that the expected variance (for a one country sample, in the time dimension) of CA/Y is just given by

$$\text{Var}(CA/Y) = \frac{\sigma^2}{1-\rho^2}, \tag{8}$$

where $\rho = 1 - \beta$ is a persistence parameter. Hence, as is intuitively obvious, countries will only have large current accounts (according to this variance measure used in Figure 1) if their dynamics allow it: if shocks are large or if the convergence speed is slow (that is, persistence is high).

This intuition generalizes to AR(p) processes with p lags, provided they are linear processes, since the variance of the left-hand side of equation 8 is separable into the effects of the internal dynamics of the system (a function of the coefficients) and the variance of the error term (which must enter linearly into the variance of the left-hand side). Thus, one way to resolve the FH puzzle is to see exactly what kind of sustained current account imbalances the dynamics do in fact permit.

Table 2 and Figure 4 show the results for the AR(1) model. These results are very striking in that they confirm, for the first time in a *dynamic* model of current account adjustment, the stylized facts of the historical literature concerning capital mobility.[10]

Looking first at the pooled data in Table 2 we see that the convergence speed (β) was very low in the pre-1914 era, about 34% per annum. That is, current account deviations had a half-life of about 1.5 years, suggesting considerable flexibility to

[9] After 1870 the sample always includes between 12 and 15 countries—not a huge sample, but comparable in size to Feldstein and Baccheta’s (1991) sample of nine EC countries.
[10] Individual country results are shown in Tables A.1–A.4 in the appendix.

Table 2
Current account dynamics (pooled sample)

						Specification tests		
Countries	Periods	β	σ	R^2	T	No lags	Pooling periods	Pooling countries
Pooled	Pooled	-0.31 (0.02)	0.028	.16	1840	.00	.00	.00
Pooled	Gold Std.	-0.34 (0.03)	0.027	.17	498	.00		.07
Pooled	Interwar	-0.41 (0.04)	0.037	.22	417	.00		.01
Pooled	B. Woods	-0.74 (0.04)	0.021	.45	376	.29		.01
Pooled	Float	-0.32 (0.04)	0.017	.16	315	.00		.89

Notes and sources: See text and appendix. No Lags tests for up to 6 lags, Pooling Periods for common structure across periods, Pooling Countries for common structure across countries. All tests are F-tests.

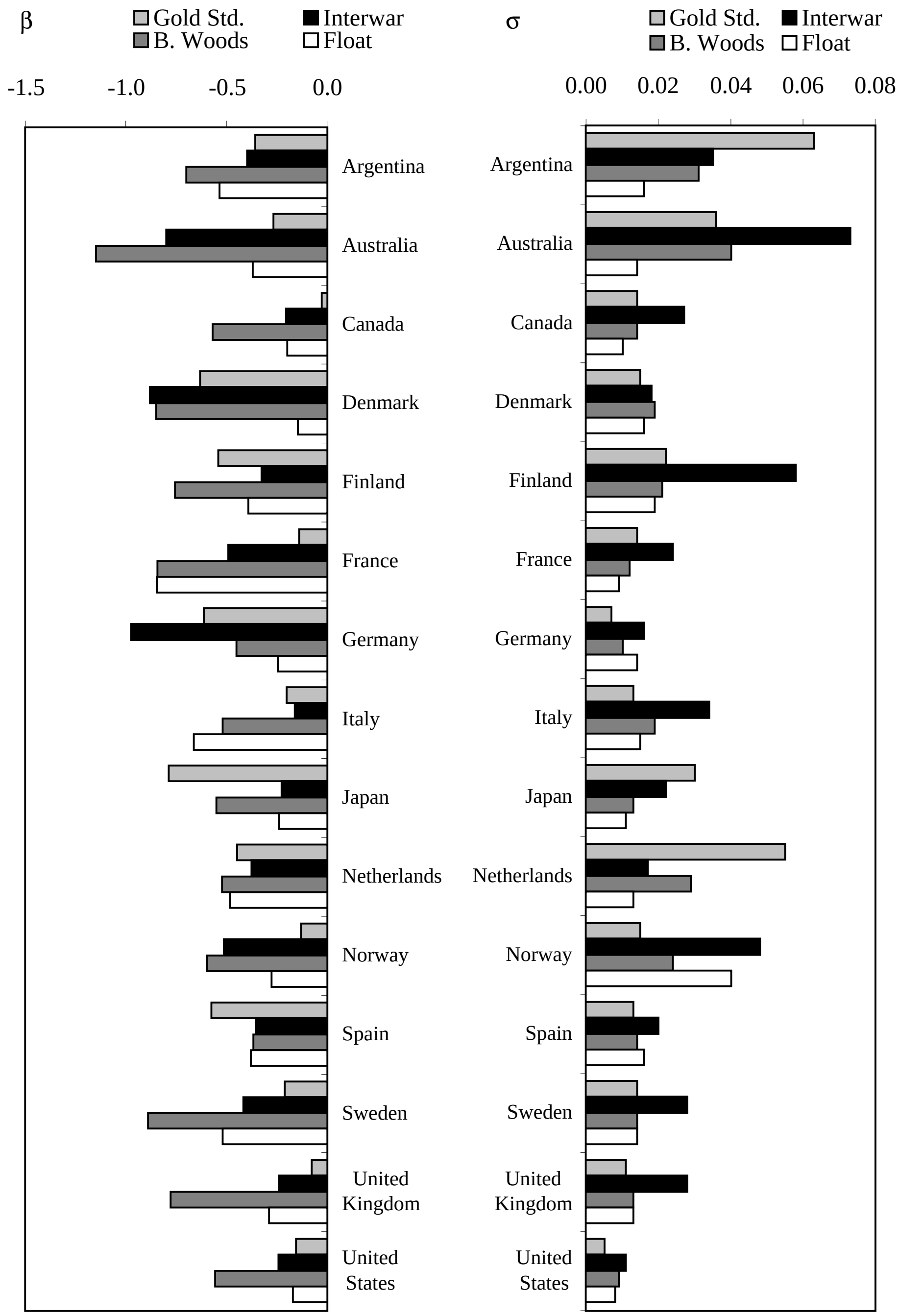
smooth shocks over medium to long horizons. This freedom to adjust was reduced in the inter-war period, as the convergence speed rose to about 41% per annum, implying a half-life of about 1.2 years. It was curtailed yet further under the Bretton Woods era when the convergence speed rose again to 74%, with a half-life now well under one year. Only in the recent floating period has flexibility returned to the current account in this sample, with a convergence speed of 32%, not significantly different from the pre-1914 estimate, though still a little higher as a point estimate.

These findings accord with the notion that the Bretton Woods re-design of the international financial architecture, as it sought to avoid a repeat of volatile inter-war conditions, had as its intent a virtual shutting down of international capital markets—and was very successful in achieving that end. We also find that the contemporary period looks little different than the gold standard period of a century ago in terms of current account flexibility.

A brief look at the error variance (σ) reveals no surprises given our historical priors. Shocks were largest during the turbulent inter-war years, just as flexibility started to be lost—despite large shocks measured by σ, the lack of flexibility as measured by β prevented large flows from developing. Shocks were smallest in both postwar periods, both during and after Bretton Woods—and that seems entirely consistent with the long-lasting impact of a highly controlled system designed to both limit capital mobility and prevent shocks.

The pre-1914 had shocks larger than the postwar period, smaller than the inter-war; yet it also had the flexibility to handle them rather well. Thus, the Bretton Woods re-design was based on a valid premise—high volatility in international capital markets during the inter-war period. However, it seems clear that the solution was based not a return to market-based smoothing of shocks, as in the pre-1914 era, with highly flexible capital flows, but rather an attempt to shut down both the flows and the shocks themselves.

Fig. 4. Current account dynamics: adjustment speeds and error variance



Notes and Sources: See text and appendix.

5. Cross-country variation and the stylized facts

Are such inferences valid in all countries? Is it reasonable to conclude that the policy reactions of the inter-war period, and their legacy under Bretton Woods, made the mid-twentieth century a period of low capital mobility? The trouble with the pooled samples is that they may not be a reasonable sample given the implied restrictions on the regressions. As Table 2 shows it is easy to reject pooling across countries, at the 1% level in all cases except the float. It is also the case that the simple specification with no lags of $\Delta(CA/Y)_t$ is doubtful, given a specification test on the inclusion of additional (up to six) lags. With country-by-country estimation, the absence of a complex lag structure is usually accepted.

Loosening up the specification in this way, whilst allowing us to admit different dynamics for each country, does not significantly alter our historical interpretation overall, though it does reveal some interesting heterogeneity of experience. In Figure 4 we see that for most countries the peak in the adjustment speed is experienced in the Bretton Woods period (9 out of 15 cases). Denmark, France, and Italy are fairly close, which leaves three other cases. Germany has its peak in the inter-war period, which is as expected given the severe constraints on borrowing imposed after Versailles, and only briefly eased by the Dawes plan. Japan has a much larger peak in the pre-1914 period, which is no surprise given the then-recent advent of the Meiji reforms. Spain's pre-1914 peak might be reasonable given that she was a country on the periphery at that time, and somewhat isolated from the group of well-integrated gold standard countries by dint of her preference for silver money. Even so, given wide standard errors, none of these cases present examples where having a peak in the Bretton Woods era can be definitively rejected.

The error variances also accord well with the pooled results, with peak volatility in the inter-war period again in 11 out of 15 cases. Unsurprisingly, volatility is much larger for the smaller economies: the U.S. variance is very small indeed as compared to countries like Argentina, Australia, Netherlands, and Norway. The Danish case is also too close to call, and there are three exceptions to worry about once more. Argentina has its biggest error variance before 1914, which is no news to anyone familiar with the massive disruptions that caused, and then were caused by, the Baring Crisis—as massive herding in of foreign capital gave way to a sharp reversal and several years of austerity and outflows to settle debts. Even so, Argentina's inter-war variance is still very high by world standards. Japan and Netherlands also have high variance before 1914. In each country we have fragile data in this period, so that is one possible source of noise—as is also true of Argentina. The Dutch were big players, as capital exporters, in the global capital market at this time, relative to country size, so that also argues for a volatile external balance. Newly-opened Japan also might have been exposed as an emerging market, like Argentina, to a good deal of turbulence in this era relative to the size of their economy. The one other unusual spike in error variance outside the interwar period—Norway in the Floating era—is clearly related to a resource shock, the discovery of North Sea oil, an episode that is by now a textbook example of current account adjustment dynamics.

One would not wish to claim that we can, nor that we should desire, an historical account of this sort to say why each and every parameter has the value it does at each moment in time. There is an obvious danger of overexplanation. It is merely worth noting at this juncture that, given the historical priors we have garnered from various sources over the years—concerning capital market flexibility and the shocks to the external balances seen over time and across countries—we have been able to corroborate such claims in a dynamic model of the current account applied to long-run data.

6. A vector error-correction model of saving and investment

We have shown that the current account ratio CA/Y is stationary. It immediately follows that the saving and investment ratios, S/Y and I/Y, must be cointegrated, since $CA/Y = S/Y - I/Y$ is an identity. Hence, without loss of generality, we can adopt a vector error-correction representation as a dynamic model of saving and investment. Let $s = S/Y$, $i = I/Y$, and let $z = CA/Y$ be the cointegrating term. Then, the dynamics of s and i take the form,

$$\begin{pmatrix} \Delta s_t \\ \Delta i_t \end{pmatrix} = \begin{pmatrix} \alpha_s \\ \alpha_i \end{pmatrix} + \sum_{j=1}^{p} \begin{pmatrix} \beta_{ssj} & \beta_{sij} \\ \beta_{isj} & \beta_{iij} \end{pmatrix} \begin{pmatrix} \Delta s_{t-j} \\ \Delta i_{t-j} \end{pmatrix} + \begin{pmatrix} \gamma_s \\ \gamma_i \end{pmatrix} z_{t-1} + \begin{pmatrix} \epsilon_{st} \\ \epsilon_{it} \end{pmatrix}, \tag{9}$$

where we expect $\gamma_s < 0$ and $\gamma_i > 0$, implying that current account deficits (surpluses) bring about adjustment via savings increases (decreases) and investment decreases (increases).

The model presented here has a very general lag structure, and it is clear that it implies a more general dynamic model for $z = CA/Y$ than we have seen in the previous section. Subtracting row two from row one in the above equation, we find that

$$\Delta z_t = \alpha_z + \sum_{j=1}^{p} \begin{pmatrix} \beta_{ssj} - \beta_{isj} & \beta_{sij} - \beta_{iij} \end{pmatrix} \begin{pmatrix} \Delta s_{t-j} \\ \Delta i_{t-j} \end{pmatrix} + \gamma_z z_{t-1} + \epsilon_{zt}, \tag{10}$$

where $\alpha_z = \alpha_s - \alpha_i$, $\gamma_z = \gamma_s - \gamma_i$, and $\epsilon_z = \epsilon_s - \epsilon_i$. Only under certain restrictions would a pure AR representation of CA/Y obtain, independent of lagged S/Y and I/Y, and this would depend on having identical β coefficients in each row.

The dynamic saving and investment model avoids some of the pitfalls of the FH approach. The model is not *ad hoc*, and it does directly account for the LRBC problem. And because it links to the current account dynamics it gives us a way of comparing flexibility in the current account to saving and investment dynamics. In particular, changes in the adjustment speeds $\gamma_s < 0$ and $\gamma_i > 0$ will directly affect the current account adjustment speed, $\gamma_z = \gamma_s - \gamma_i < 0$. And changes in the saving-investment error variance $\text{Var}(\epsilon_t)$ will affect the current account error variance, $\text{Var}(\epsilon_z) = \text{Var}(\epsilon_s - \epsilon_i) = \text{Var}(\epsilon_s) - 2\text{Cov}(\epsilon_s, \epsilon_i) + \text{Var}(\epsilon_i)$.

7. Dynamic model parameters and FH regression implications

We have a dynamic model of s, i, and $z = s - i$, and we can interpret adjustment speeds and error variances as telling us something about current account flexibility and volatility. How do these time-series parameters relate to the FH cross-section results? Is there any relationship between capital market integration as measured by the dynamic parameters and the FH coefficient?

To assess this link I undertook the following simulation exercise. First, I fit the model on actual data. Next, I simulated 100 years of data from a 1900 starting point for all 15 countries. Then I took the simulated 1990–99 data and performed cross-section FH regressions. I found the b (FH) coefficient for each simulation, and repeated for 1,000 simulations. This yielded the distribution of the b coefficient. [11]

Next, I repeated the whole exercise for different adjustment speeds $\gamma_z = \gamma_s - \gamma_i$, and different error variances $\mathrm{Var}(\epsilon_z) = \mathrm{Var}(\epsilon_s - \epsilon_i)$. How did I choose a range of parameters? I took the base calibration of the (s, i) model and left the lag structure and its parameters unchanged. But I did change convergence speeds and error variances. I replaced γ with $\phi\gamma$ for various multipliers ϕ, and similarly I replaced $\mathrm{Var}(\epsilon)$ with $\phi\mathrm{Var}(\epsilon)$.

I then tabulated the results so as to see how changes in the underlying dynamic parameters of the (s, i) model—the parameters I take as the true measures of the underlying mobility of capital—affect b, the FH coefficient. [12]

Table 3 shows the basic results for changes in one set of parameters at a time. Holding the error variance fixed, and rescaling the convergence speed in the (s, i) model shows that faster convergence speeds (of s, i, and, hence, z) are associated with larger FH coefficients, and the whole range runs from a low of $b = 0.5$ (when the convergence speed is cut by a factor of $\phi = 0.01$) to a high of $b = 1$ (for $\phi = 5$). [13] This is intuitive: if the current account adjusts very quickly back to zero, then for a given distribution of shocks we will very rarely see saving and investment

[11] The fitted model had

$$\begin{pmatrix} \gamma_s \\ \gamma_i \end{pmatrix} = \begin{pmatrix} -0.12 \\ 0.08 \end{pmatrix}, \mathrm{Var}\begin{pmatrix} \epsilon_s \\ \epsilon_i \end{pmatrix} = \begin{pmatrix} 0.00100 & 0.00046 \\ 0.00046 & 0.00065 \end{pmatrix},$$

implying that γ_s and γ_i had the expected signs, $\gamma_z = -0.20$, and $\mathrm{Var}(\epsilon_z) = 0.00073$.

[12] The first draft of this paper (Taylor 1996) approached the dynamic modeling exercise with a single-equation ECM model following Jansen and Schulze (1996). The VECM model developed here is much more general, and does not require a weak-exogeneity assumption for saving. Using the single-equation ECM framework, in independent work, Jansen (1997) used a simulation approach to show how parameter shifts in the ECM could affect the cross-sectional implied FH coefficient. Our exercise is in the same vein, but it is calibrated to actual historical processes, whereas Jansen used *ad hoc* parameter choices to make an artificial cross-section of countries. We also do not assume a random walk for saving as he did, but instead model saving as part of a VECM process.

[13] When $\phi > 5$ the convergence speed γ_z exceeds one, the model implies unrealistic oscillations, and the results are suppressed.

Table 3
Simulated FH parameters

Scaling factor		FH regression coefficient					
Adjustment speed	VCV matrix	Annual		5-year		10-year	
0.01	1.00	0.48	(0.19)	0.51	(0.16)	0.48	(0.16)
0.05	1.00	0.56	(0.16)	0.61	(0.15)	0.59	(0.17)
0.10	1.00	0.71	(0.12)	0.70	(0.13)	0.72	(0.14)
0.20	1.00	0.81	(0.14)	0.82	(0.11)	0.84	(0.11)
0.50	1.00	0.91	(0.09)	0.91	(0.07)	0.94	(0.07)
1.00	1.00	0.96	(0.07)	0.97	(0.05)	0.97	(0.05)
2.00	1.00	0.97	(0.06)	0.98	(0.04)	0.99	(0.03)
5.00	1.00	0.98	(0.06)	1.00	(0.02)	1.00	(0.01)
1.00	0.01	1.00	(0.02)	1.00	(0.01)	1.00	(0.01)
1.00	0.05	0.98	(0.04)	0.99	(0.03)	0.99	(0.03)
1.00	0.10	0.97	(0.05)	0.97	(0.04)	0.98	(0.04)
1.00	0.20	0.96	(0.06)	0.97	(0.05)	0.97	(0.05)
1.00	0.50	0.96	(0.06)	0.97	(0.06)	0.97	(0.04)
1.00	1.00	0.94	(0.07)	0.97	(0.06)	0.97	(0.05)
1.00	2.00	0.94	(0.06)	0.96	(0.06)	0.97	(0.06)
1.00	5.00	0.95	(0.07)	0.95	(0.06)	0.97	(0.05)
1.00	10.00	0.94	(0.07)	0.96	(0.06)	0.96	(0.05)
1.00	20.00	0.94	(0.07)	0.96	(0.06)	0.97	(0.05)
1.00	50.00	0.94	(0.07)	0.96	(0.06)	0.96	(0.05)

Notes and Sources: See text and appendix.

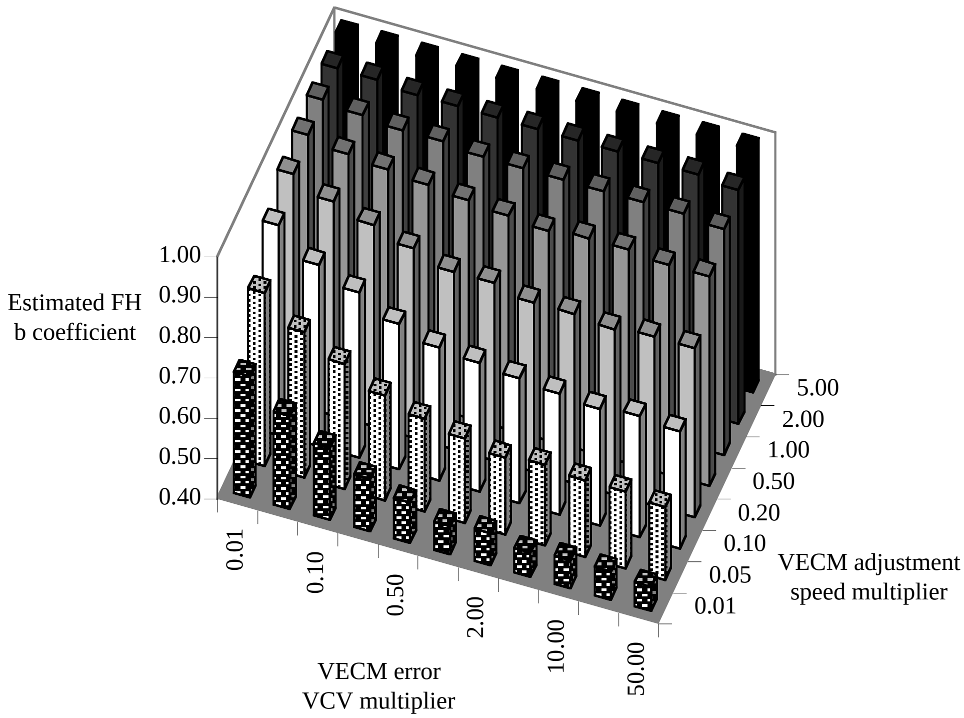
taking on unequal values and we would expect a high b estimate.

An alternative experiment holds the convergence speeds fixed and rescales the size of the error shocks, again using the real data for the base calibration. When I perform this experiment there is a monotonic relationship of sorts, but the magnitude of the changes in b are very small as the rescaling of shocks ranges over a multiplicative factor of $0.02 \leq \phi \leq 50$. This is a very wide range over which to see practically no variation in the FH parameter (with $0.96 < b < 1$). These preliminary results show that variations in either of the two key parameters of the model (the shock variance ϕ and the convergence speed γ) have an intuitive link to the statistic of interest (the saving-investment or FH coefficient b).

In Table 3, though, the small response of b to $\text{Var}(\epsilon_z)$ might be the result of holding γ_z fixed at a given level; the response could be bigger at other values of γ_z. We would really like to know what happens to the FH coefficient when both parameters (ϕ, γ) vary simultaneously and over a wider range. On this question, the display format of Table 3 appears inadequate for the task of clearly showing the map from these parameters to the b statistic. Accordingly we turn to a three-dimensional graphical display which, though it requires careful interpretation, may better illustrate the range of results possible in this framework.

Figure 5 plots the mapping from various imposed (ϕ, γ) pairs on the horizontal plane, to the implied value of b of the vertical axis. The figure confirms that at slower convergence speeds (smaller levels of γ_z), higher volatility (larger $\text{Var}(\epsilon_z)$) translates

Fig. 5. Simulated FH parameters



Notes and Sources: See text and appendix.

into a lower value of b, the FH coefficient. This is also an intuitive finding: bigger disturbances in the (s, i) model, should, holding the convergence speed constant, lead to bigger differences between saving and investment levels in each country, and, hence, a lower correlation of s and i in cross section.[14]

Thus, we find that simulated data from the dynamic model generate a range of FH coefficients between 0.5 and 1, an interval that encompasses the actual range seen in most FH tests, and which explains why truly small FH parameters (close to zero) are unlikely ever to be seen in practice. Thus, we might even claim to have attained some kind of holy grail: a meaningful, albeit deformed, yardstick for the FH tests can be based on these simulations. *Very* low convergence speeds can push b as low as about 0.5—but rarely lower in practice; so this is a plausible lower extreme on the scale. Conversely, fast convergence speeds soon push b close to one, the plausible high extreme on the scale.

[14] Figure 5 shows only the results for 10-year-averaged samples. The results are similar for 1-year and 5-year averaging.

8. Conclusion

This paper has related saving and investment patterns in cross section to formal time series properties implied by intertemporal budget balance. Econometric estimation and simulation exercises apply a VECM model and show that dynamic model parameters for a panel of 15 countries over 100 years deliver a plausible interpretation of changes in global capital mobility consistent with the conventional wisdom of our traditional historical narratives.

Our modeling strategy can also help shed some light on the supposed Fedlstein-Horioka "puzzle." As is well known, there are a number of theoretical models that can deliver an FH "puzzle" even with capital mobility. Under certain parameter assumptions, and with a particular market structure, these models deliver a positive saving-investment association. It is of empirical interest, however, to know whether such models apply in practice.

Using the calibration methods above, we find that the underlying dynamics of saving and investment in our historical sample tend to generate a monotonic relationship between current account persistence parameters, shock variances, and the estimated FH coefficient. So, in this real-world application at least the often asserted relationship between the FH parameter and underlying measures of mobility appears to be valid.

Are the conclusions limited and model-specific? They should not be. The LRBC must be a common feature of all useful models in international finance, with or without growth, whether deterministic or stochastic. From the LRBC restriction, certain implied time-series dynamics for debts and the current account must follow—dynamics that must resemble the models estimated here.

Given the fragility of inference in the FH regression, a time-series approach offers a more direct method of evaluating capital mobility, one that might be preferred for its richer description of dynamics, its firmer basis in the theory of the long run budget constraint, and its ability to detect country-specific differences in the world capital market. Future studies might extend this result with applications to other samples, and closed-form solutions might arise in some classes of models.

It would also be helpful to see the dynamic model coefficients derived from the deep parameters (describing tastes, technology and other processes) of optimizing open-economy models, or at least their linearization around steady states. There the current account dynamics might depend on other real state variables (like output, investment, and government spending shocks, as in real business cycle models) and nominal variables (like exchange rate, price, and money shocks as in models with rigidities).

A Appendix

Appendix Tables A.1–A.4 show the country-specific ECM models.

The data used in the paper consists of annual saving and investment rates for each of the 15 countries in the sample. Data was collected for every available year between 1850 and 1992. The data are available from the author upon request. The following abbreviations are used for each country:

ARG	Argentina	AUS	Australia
CAN	Canada	DNK	Denmark
FIN	Finland	FRA	France
DEU	Germany	ITA	Italy
JPN	Japan	NLD	Netherlands
NOR	Norway	ESP	Spain
SWE	Sweden	GBR	United Kingdom
USA	United States		

1850–1945: The investment rate measure $(I/Y)_t$ is the ratio of gross investment I_t to national income Y_t at current local prices; the saving rate $(S/Y)_t$ was usually calculated implicitly, via the current account identity, as the investment rate $(I/Y)_t$ plus the ratio of the current account CA_t to national income: $(I/Y)_t = I_t/Y_t$, $(S/Y)t = (I_t/Y_t) + (CA_t/Y_t)$. Except as otherwise indicated this data is taken from Jones and Obstfeld (1997), who revised the standard sources to correct for flows of gold and changes in stocks.

1946–1959: The investment and saving rates are defines as above: saving rates are still calculated residually from the current account. Except as otherwise indicated this data is taken from Mitchell (1983,1992) using his national income and overall current balance series at current prices. The overall current balance series are converted from U.S dollars using his exchange rate series as necessary.

1960–1992: Estimates of gross domestic saving, gross domestic investment, and gross domestic saving at current prices from World Bank (1994).

Exceptions are as follows:

Argentina From the reconstruction of Argentina's historical balance of payments in Taylor (1998).

Australia 1946–1988 from N. Butlin (1962), M. Butlin (1977), and McLean (1994), as described in Taylor and Williamson (1994).

Canada 1946–1984 from Urquhart (1988).

Germany Before 1945, raw data is for net capital formation. This is inflated by adding 9 percentage points to give an approximation of gross capital formation, using an assumed capital-output ratio of 3 and an assumed depreciation rate of 3%.

Netherlands Before 1914, raw data is for net capital formation. This is inflated by adding 9 percentage points to give an approximation of gross capital formation, using an assumed capital-output ratio of 3 and an assumed depreciation rate of 3%.

Spain Before 1965, based on revisions to Albert Carreras' macroeconomic statistics chapter in Barciela et al. (1989); unpublished revisions of the investment figures, and unpublished saving estimates by Leandro Prados. For 1965–66 investment based on Carreras, with the current account from Mitchell as above.

Table A.1
Current account dynamics (individual country samples)

						Specification Tests	
Countries	Periods	β	σ	R^2	T	No lags	Pooling periods
Argentina	Pooled	-0.29 (0.07)	0.042	.15	107	.44	.13
Argentina	Gold Std.	-0.36 (0.15)	0.063	.18	28	.43	
Argentina	Interwar	-0.40 (0.14)	0.035	.20	32	.40	
Argentina	B. Woods	-0.70 (0.18)	0.031	.40	26	.28	
Argentina	Float	-0.53 (0.22)	0.016	.24	21	.92	
Australia	Pooled	-0.43 (0.07)	0.051	.22	131	.01	.03
Australia	Gold Std.	-0.27 (0.12)	0.036	.13	34	.91	
Australia	Interwar	-0.80 (0.19)	0.073	.36	32	.67	
Australia	B. Woods	-1.15 (0.18)	0.040	.63	26	.87	
Australia	Float	-0.37 (0.17)	0.014	.19	21	.45	
Canada	Pooled	-0.11 (0.04)	0.020	.05	122	.00	.00
Canada	Gold Std.	-0.02 (0.08)	0.014	.00	34	.21	
Canada	Interwar	-0.20 (0.10)	0.027	.12	32	.12	
Canada	B. Woods	-0.57 (0.09)	0.014	.65	26	.34	
Canada	Float	-0.20 (0.15)	0.010	.09	21	.61	
Denmark	Pooled	-0.45 (0.09)	0.018	.19	111	.59	.01
Denmark	Gold Std.	-0.63 (0.16)	0.015	.33	34	.60	
Denmark	Interwar	-0.88 (0.23)	0.018	.38	25	.70	
Denmark	B. Woods	-0.85 (0.19)	0.019	.45	26	.80	
Denmark	Float	-0.15 (0.20)	0.016	.03	21	.85	

Table A.2
Current account dynamics (individual country samples)

						Specification Tests	
						No	Pooling
Countries	Periods	β	σ	R^2	T	lags	periods
Finland	Pooled	-0.31 (0.06)	0.035	.15	132	.11	.84
Finland	Gold Std.	-0.54 (0.16)	0.022	.27	34	.51	
Finland	Interwar	-0.33 (0.14)	0.058	.16	32	.57	
Finland	B. Woods	-0.76 (0.20)	0.021	.36	26	.29	
Finland	Float	-0.39 (0.19)	0.019	.18	21	.62	
France	Pooled	-0.39 (0.05)	0.017	.35	131	.67	.03
France	Gold Std.	-0.14 (0.09)	0.014	.07	34	.55	
France	Interwar	-0.49 (0.09)	0.024	.59	25	.70	
France	B. Woods	-0.84 (0.19)	0.012	.49	22	.58	
France	Float	-0.85 (0.23)	0.009	.42	21	.40	
Germany	Pooled	-0.44 (0.08)	0.011	.23	96	.17	
Germany	Gold Std.	-0.61 (0.16)	0.007	.31	34	.99	
Germany	Interwar	-0.97 (0.27)	0.016	.55	13	.76	
Germany	B. Woods	-0.45 (0.18)	0.010	.24	21	.76	
Germany	Float	-0.24 (0.17)	0.014	.10	21	.06	
Italy	Pooled	-0.19 (0.05)	0.022	.09	131	.16	.68
Italy	Gold Std.	-0.20 (0.11)	0.013	.10	34	.95	
Italy	Interwar	-0.16 (0.11)	0.034	.07	32	.05	
Italy	B. Woods	-0.52 (0.11)	0.019	.47	26	.21	
Italy	Float	-0.66 (0.21)	0.015	.34	21	.41	

Table A.3
Current account dynamics (individual country samples)

Countries	Periods	β	σ	R^2	T	Specification Tests: No lags	Specification Tests: Pooling periods
Japan	Pooled	-0.40 (0.08)	0.022	.20	105	.29	.04
Japan	Gold Std.	-0.79 (0.19)	0.030	.39	28	.87	
Japan	Interwar	-0.22 (0.12)	0.022	.12	31	.04	
Japan	B. Woods	-0.55 (0.20)	0.013	.26	25	.81	
Japan	Float	-0.24 (0.16)	0.011	.11	21	.12	
Netherlands	Pooled	-0.31 (0.07)	0.041	.16	116	.68	
Netherlands	Gold Std.	-0.45 (0.14)	0.055	.23	34	.92	
Netherlands	Interwar	-0.38 (0.30)	0.017	.18	9	.88	
Netherlands	B. Woods	-0.52 (0.18)	0.029	.28	23	.17	
Netherlands	Float	-0.48 (0.18)	0.013	.28	21	.07	
aNorway	Pooled	-0.37 (0.07)	0.032	.18	120	.17	.91
Norway	Gold Std.	-0.13 (0.09)	0.015	.07	34	.41	
Norway	Interwar	-0.51 (0.18)	0.048	.26	26	.42	
Norway	B. Woods	-0.60 (0.19)	0.024	.30	25	.31	
Norway	Float	-0.27 (0.16)	0.040	.13	21	.81	
Spain	Pooled	-0.36 (0.07)	0.015	.18	142	.02	.91
Spain	Gold Std.	-0.57 (0.16)	0.013	.30	34	.69	
Spain	Interwar	-0.35 (0.14)	0.020	.17	32	.48	
Spain	B. Woods	-0.36 (0.16)	0.014	.18	26	.23	
Spain	Float	-0.38 (0.17)	0.016	.21	21	.11	

Table A.4
Current account dynamics (individual country samples)

Countries	Periods	β	σ	R^2	T	Specification tests: No lags	Specification tests: Pooling periods
Sweden	Pooled	-0.31 (0.06)	0.019	.16	131	.21	.42
Sweden	Gold Std.	-0.21 (0.12)	0.014	.09	34	.83	
Sweden	Interwar	-0.42 (0.16)	0.028	.19	32	.03	
Sweden	B. Woods	-0.89 (0.15)	0.014	.59	26	.00	
Sweden	Float	-0.52 (0.19)	0.014	.27	21	.46	
United Kingdom	Pooled	-0.15 (0.05)	0.019	.07	142	.40	.28
United Kingdom	Gold Std.	-0.08 (0.09)	0.011	.02	34	.06	
United Kingdom	Interwar	-0.24 (0.11)	0.028	.13	32	.05	
United Kingdom	B. Woods	-0.78 (0.12)	0.013	.63	26	.14	
United Kingdom	Float	-0.29 (0.15)	0.013	.16	21	.33	
United States	Pooled	-0.17 (0.05)	0.009	.09	123	.16	.39
United States	Gold Std.	-0.15 (0.09)	0.005	.09	34	.20	
United States	Interwar	-0.24 (0.12)	0.011	.12	32	.39	
United States	B. Woods	-0.55 (0.18)	0.009	.28	26	.50	
United States	Float	-0.17 (0.12)	0.008	.09	21	.74	

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