Pergamon

Journal of International Money and Finance, Vol. 15, No. 3, pp. 467–474, 1996

S0261-5606(96)00014-9
0261-5606/96 $15.00 + 0.00

International capital mobility: evidence from panel data

ROBERT KROL*

Department of Economics, California State University, Northridge, CA 91330-8245, USA and Research Associate, Milken Institute for Job and Capital Formation, Santa Monica CA 90401, USA

To test whether capital is internationally mobile, some researchers have examined the relationship between saving and investment. Using time averaged data, they find saving and investment to be related, and conclude that capital is relatively immobile. In this paper, I argue that a country's intertemporal budget constraint biases results using time averaged data against finding capital mobility. Using annual data, pooled for 21 OECD countries over the 1962–90 period, I find the estimated impact of saving on investment to be considerably smaller than previous estimates. (JEL F32). Copyright © 1996 Elsevier Science Ltd

The degree of international capital mobility determines the efficiency of capital allocation in the world economy. One test for capital mobility is to compare interest rates across countries.[1] An alternative test, proposed by Feldstein and Horioka (1980), directly examines the relationship between saving and investment in an open economy. Their test involves regressing investment and saving (both as a share of GDP), for a cross-section of OECD countries. Using averaged data (in order to remove the influence of the business cycle), they found capital to be relatively immobile internationally. These results have been confirmed by many others and have become a stylized fact in the literature (see Tesar, 1991, or Obstfeld, 1993, for recent surveys).

In this paper, I argue that the use of time-averaged data in cross-sectional investment–saving regressions, like the ones estimated by Feldstein and Horioka, biases the results against capital mobility. As pointed out by Sinn (1992), the intertemporal budget constraint of an open economy does not allow

*I would like to thank Shirley Svorny, Mark Toma and the referees for helpful comments and Holly Hatch for research assistance. The views in this paper are those of the author and may not reflect the opinions of the MIJCF.

a country to run current account surpluses or deficits indefinitely. Surpluses are followed by deficits and vice versa. Under these conditions, country-level observations based on averages of annual data will obscure surpluses and deficits over time. Saving and investment will appear more similar then they really are. Researchers may conclude that capital is not mobile internationally when, in fact, it is.

In an attempt to resolve this empirical question, I estimate saving and investment equations using annual rather than time-averaged data. I pool annual data for the period 1962 to 1990 for 21 OECD countries. The results suggest that capital is mobile internationally. Additional results show that both investment and saving have a significant impact on the current account, further supporting the hypothesis that capital is mobile.

I. Testing capital mobility

The approach taken by Feldstein and Horioka (1980) to test international capital mobility was novel in that they chose to examine the relationship between saving and investment, rather than comparing real interest rates across countries. They assume a country can borrow or lend all they want at the world real interest rate. Feldstein and Horioka test the hypothesis of perfect capital mobility by estimating the following cross-sectional equation:

$$\langle 1 \rangle \qquad I(i)/\mathrm{GDP}(i) = a + b\, S(i)/\mathrm{GDP}(i) + e(i).$$

Here I is investment, S is saving and GDP is gross domestic product. Measures of both gross and net investment (and saving) are typically used. i is a country index, a and b represent parameters to be estimated and e is the error term. The estimated value of the slope coefficient b is the parameter of interest. For a small, open economy where capital is perfectly mobile internationally, b should be close to zero.[2] If b equals zero, then there is no relationship between domestic saving and investment; any additional saving is part of a world pool of saving seeking the highest return worldwide. If b is large, however, capital is considered immobile internationally. For example, if b equals one, then all additional saving goes to finance domestic investment.[3]

Feldstein and Horioka (1980), along with the other cross-sectional studies that followed, use averaged measures of saving and investment in their empirical analysis. In using averages of annual data itself, Feldstein and Horioka hope to remove the business cycle, which they thought might bias their results toward finding capital immobility.

Using time-averaged data, Feldstein and Horioka (1980) find the estimated cross-sectional slope coefficient (b in equation ⟨1⟩ above) for a group of OECD countries to equal 0.89 over the full sample period 1960–74. Comparable results were found for sub-periods. They conclude that almost 90 percent of domestic saving remains within a country to finance domestic investment; capital is not internationally mobile.[4] Their results have been confirmed in subsequent cross-sectional papers by Feldstein (1983), Feldstein and Bacchetta (1991), Obstfeld (1993) and many other authors.[5,6]

II. Additional issues and a new test

By using averages instead of yearly measures (in an attempt to eliminate the effects of the business cycle), previous researches hoped to examine the long-term relationship between variables. There are two problems with this. First, it is not clear that averaging data over five or ten years is sufficient to establish a long-run relationship. Furthermore, capital mobility is not just a long-run issue. Second, averaging data can introduce a new empirical problem. Offsetting changes in investment and saving over time may suggest a relationship between investment and saving when none exists. As a result, international capital mobility may be incorrectly rejected.

Sinn (1992) argues that a country's intertemporal budget constraint prevents a country from borrowing or lending indefinitely (see also Blanchard and Fischer, 1989). For example, when a country has a current account deficit, it is unlikely that world lenders will continue to lend additional funds.[7]

With this constraint, the present value of all current account imbalances must equal zero. In a two-period case, the constraint can be expressed as

$$CA(t) + CA(t+1)/(1+r) = 0. \qquad \langle 2 \rangle$$

Here CA is the current account balance in period t or $t+1$ and r is the real interest rate. Equation ⟨2⟩ tells us that a current account deficit in period $t[CA(t) < 0]$ must be offset by a current account surplus in period $t+1[CA(t+1) > 0]$. In other words, the borrowing that occurs in period t must be paid back in the future (period $t+1$ in this example).

By definition, the current account balance of a country in any one period equals the difference between investment and saving. Because the current account must average zero over time, so too must the difference between investment and saving. The averaged difference between investment and saving equaling zero introduces a correlation between the two variables. Cross-sectional investment-saving regressions using time-averaged data will tend to reject international capital mobility.

To avoid this problem, this paper uses annual data. A panel data set of annual observations of investment, saving and current account balances is used for 21 OECD countries. Panel data allows us to control for business cycle effects without averaging the data. It allows us to control for country size effects as well.

There is evidence that an international business cycle exists. Backus *et al.* (1992) present evidence of positive output covariance across countries. As a result of the international business cycle, saving and investment can move together, independent of the degree of capital mobility. This needs to be controlled for empirically.

At the country level, some countries may be large enough relative to world financial markets, so that a change in saving or investment affects world interest rates. This causes saving and investment in large countries to move together. For example, when a large country experiences a positive shock to its saving function, world interest rates can decline, causing investment in the country experiencing the shock to increase. Investment and saving will be correlated even with capital mobility.[8]

Panel data allow us to control for unobserved or unmeasured country effects, like a country's size, and time period effects caused by the international business cycle, in estimation. It is possible to remove or control for the impact of these factors in estimation, to avoid model misspecification. Using panel data, we are able to get an alternative and more efficient estimate on the saving–investment relationship among OECD countries, than that associated with regressions on time-averaged data.

The fixed-effects model estimated here is:

$$\langle 3 \rangle \quad I(i,t)/\mathrm{GDP}(i,t) = a + c(i) + d(t) + bS(i,t)/\mathrm{GDP}(i,t) + e(i,t).$$

The index i represents the country and the index t represents time. The dummy variable $c(i)$ takes on a different value for each country while $d(t)$ takes on a different value for each period. $c(i)$ removes fixed differences between countries (size) and $d(t)$ removes time related factors common to all countries included in the sample (the international business cycle). Equation ⟨3⟩ can be estimated using OLS (for details see Greene, 1993).

III. Econometric results

The data used in this paper are from the *OECD National Accounts* Main Aggregates, Volume I, 1992. The variables used are gross and net investment, gross and net saving, gross domestic product and the current account balance for the period from 1962 to 1990.[9] The results from the fixed-effects estimates of the investment–saving equation are reported in Table 1.[10] To see if the movement to more flexible exchange rates and the general liberalization of

TABLE 1. Estimates of the investment–saving equation

$I(i,t)/\mathrm{GDP}(i,t) = a + b\,S(i,t)/\mathrm{GDP}(i,t) + e(i,t)$				
		Panel A		
Gross investment and saving	a	b	R^2	F-statistic
1962–90	0.18 (0.01)	0.20 (0.03)	0.64	29.4
1975–90	0.19 (0.01)	0.16 (0.04)	0.65	22.3
		Panel B		
Net investment and saving	a	b	R^2	F-statistic
1962–90	0.08 (0.01)	0.34 (0.02)	0.58	22.3
1975–90	0.08 (0.01)	0.24 (0.04)	0.60	17.8

Notes: Standard Errors are reported in parentheses. The F-statistic tests the hypothesis of no country effects. F-test degrees of freedom are (20,587) for the 1962–90 sample and (20,327) for the 1975–90 sample. All results are significant at the 1 percent level. The estimates are based on a fixed-effects model.

financial markets in the 1970s affected capital mobility, separate regressions are estimated for the 1975–90 period. Panel A reports results using measures of gross investment and saving and Panel B reports results using net investment and saving.

The estimated slope coefficient b in Panel A is 0.20. This is a precise estimate with a p-value of 0.00 and considerably smaller than the previous estimates in the existing literature. The estimated slope coefficient decreases to 0.16 for the period beginning in 1975. Using annual data, not only do we observe capital mobility, but we find it has increased over time.[11] The regressions using net values have somewhat higher slope estimates (Panel B). This result is consistent with Feldstein's (1983) argument that measurement error in the calculation of depreciation leads to higher coefficient estimates using net variables. The coefficients are still relatively small, however, indicating capital mobility across countries.

F-statistics suggest that country effects are important but time effects are not. Looking at country effects alone, the null hypothesis that there are no country effects is strongly rejected at less than the 1 percent level in every case. While not reported here, the F-statistics that compare a model with country effects to one with country and time-period effects are always close to zero. The international business cycle does not appear to be a significant factor in the analysis.

To test for simultaneous equation bias, I use a test developed by Spencer and Berk (1981), which is a limited information version of the Hausman test. For each regression, the hypothesis of simultaneous equation bias is strongly rejected.[12]

The results in Table 1 support the hypothesis that the large slope coefficient in the existing literature results from problems with the estimation technique. Once annual data are used, the empirical estimate of the slope coefficient drops dramatically. The results suggest that the marginal-saving-retention ratio for this group of OECD countries is fairly small and has fallen over time, less than 20 percent using gross measures. This strongly supports the notion that capital is mobile in the world economy.

For completeness, I estimate regressions replicating Sachs' current account capital mobility test, but using annual panel data.[13] Equations ⟨4⟩ and ⟨5⟩ represent versions of the capital mobility test suggested by Sachs (1981, 1983).

$$\langle 4 \rangle \qquad CA(i,t)/\mathrm{GDP}(i,t) = a + b\, I(i,t)/\mathrm{GDP}(i,t) + e(i,t).$$

$$\langle 5 \rangle \qquad CA(i,t)/\mathrm{GDP}(i,t) = a + b\, S(i,t)/\mathrm{GDP}(i,t) + e(i,t).$$

Using Sachs' approach, if capital is internationally mobile, investment (saving) should have a negative (positive) impact on the current account, holding other things constant. Current account data used here span the period from 1962 to 1990. The results are reported in Table 2. Equation ⟨4⟩ results are in Panel A and equation ⟨5⟩ results are in Panel B. As does Sachs, I find gross investment as a share of GDP to have a large and significant negative impact on the current account. Higher domestic investment leads to greater international borrowing and the resulting current account deficit.

TABLE 2. Estimates of the current account equation

Panel A: $CA(i,t)/\text{GDP}(i,t) = a + b\, I(i,t)/\text{GDP}(i,t) + e(i,t)$				
Gross investment	a	b	R^2	F-statistic
1962–90	0.14 (0.01)	−0.61 (0.06)	0.69	65.6
1975–90	0.16 (0.01)	−0.71 (0.06)	0.88	124.2
Net investment	a	b	R^2	F-statistic
1962–90	0.04 (0.01)	−0.33 (0.05)	0.66	54.5
1975–90	0.07 (0.01)	−0.60 (0.06)	0.87	112.9

Panel B: $CA(i,t)/\text{GDP}(i,t) = a + b\, S(i,t)/\text{GDP}(i,t) + e(i,t)$				
Gross saving	a	b	R^2	F-statistic
1962–90	−0.16 (0.01)	0.64 (0.03)	0.80	25.6
1975–90	−0.14 (0.01)	0.62 (0.04)	0.90	23.5
Net saving	a	b	R^2	F-statistic
1962–90	−0.07 (0.01)	0.52 (0.03)	0.78	25.0
1975–90	−0.06 (0.01)	0.55 (0.04)	0.90	22.2

Notes: See Table 1.

I also find saving as a share of GDP to have a significant positive impact on the current account balance. This result differs from Sachs, who found no significant relationship between saving and the current account balance. He concluded current account deficits are the result of investment booms. The evidence presented in this paper makes this conclusion less clear. The important point is that both results suggest that capital is mobile in the world economy.

IV. Conclusion

This paper investigates the extent of capital mobility in the world economy. The test draws on the work first done by Feldstein and Horioka (1980). They regressed investment as a share of GDP on saving as a share of GDP using time-averaged data for a cross-section of OECD countries. Their results reject the idea that capital is highly mobile internationally. This result has been confirmed in other research and has become a stylized fact in the literature.

This paper presents evidence that using time-averaged saving and investment data biases these early results in the direction of rejecting capital mobility. A panel data set is used to re-estimate the investment-saving regression. Rather than using time-averaged data, investment and saving is sampled annually for a group of OECD countries covering the period from 1962 to 1990. Panel data estimators control for country-size and international business cycle effects.

The results presented here suggest that only a small portion of domestic saving remains in a given country to fund domestic investment. Most domestic saving is simply added to the world savings pool seeking the highest return. Additional tests using the same data set show that both investment and saving have a significant impact on the current account. The results in this paper are consistent with international capital mobility.

Notes

1. See Frankel (1986, 1991) for a discussion of the issues in this literature.
2. Feldstein and Horioka (1980) realized that the sample contained some large countries which could influence interest rates, biasing the results upward. As a result, a small positive slope coefficient is consistent with capital mobility.
3. There is disagreement in the literature concerning the interpretation of the saving–investment regression. For example, Obstfeld (1986) sets up a life-cycle model of a small-open economy with perfect capital mobility. In this setting, he shows that an increase in population growth can cause both saving and investment rates to rise. In other words, it is possible for saving and investment to be correlated even with capital mobility.
4. Because saving may be correlated with the error term, they also estimate the equation using instrumental variables. Demographic variables are used as instruments for saving. The results do not change. Bayoumi (1990) also finds the results do not change with instrumental variables.
5. Obstfeld (1986, 1993), Bayoumi (1990) and Frankel (1991) investigate the problem using time-series data. The results from these papers are similar to the cross-sectional literature.
6. Summers (1988) and others have argued that the observed relationship between saving and investment is the result of government fiscal policy decisions to offset current account imbalances. Argimon and Roldan (1994) test this hypothesis for a group of EC countries and reject it.
7. Blanchard and Fischer (1989) describe this constraint as being needed to avoid Ponzi-game solutions to open-economy models. Sheffrin and Woo (1990) provide evidence supporting the idea that this constraint is binding on countries.
8. Murphy (1984) estimates the saving–investment regression separately for cross-sections of small and large countries. He finds the slope coefficient for small countries to be approximately one-half of the size of the large-country group slope coefficient. This suggests that we need to control for country size.
9. The 21 countries included are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, UK and the USA.
10. The estimated values using a random-effects model are almost identical to the fixed-effects results. In order to save space, I do not report them.
11. The OLS slope estimate without country and time effects for the full-sample equals 0.29 with a standard error of 0.02. For the 1975–90 sample, the slope estimate equals 0.19 with a standard error of 0.02. Even without controls for country size and the international business cycle, the results using annual data show much higher capital mobility than when time-averaged data are used.
12. In order to conserve space, I do not report the results. They are available on request.
13. The regression Sachs estimates can be derived from the Feldstein–Horioka regression. Sachs also uses time-averaged data.

References

ARGIMON, ISABEL AND JOSE ROLDAN, 'Saving, investment and international capital mobility in EC countries,' *European Economic Review*, 1994, **38**: 59–67.

BACKUS, DAVID, PATRICK KEHOE AND FINN KYDLAND, 'International real business cycles,' *Journal of Political Economy*, August 1992, **100**: 745–775.

BAYOUMI, TAMIM, 'Saving–investment correlations: Immobile capital, government policy, or endogenous behavior?' *IMF Staff Papers*, June 1990, **37**: 360–387.

BLANCHARD, OLIVIER J. AND STANLEY FISCHER, *Lectures on Macroeconomics*, Cambridge, MA: MIT Press, 1989.

FELDSTEIN, MARTIN, 'Domestic saving and international capital movements in the long run and the short run,' *European Economic Review*, 1983, **21**: 129–151.

FELDSTEIN, MARTIN AND PHILIPPE BACCHETTA, 'National saving and international investment,' in B. Douglas Bernheim and John B. Shoven, eds, *National Saving and Economic Performance*, Chicago: University of Chicago Press, 1991.

FELDSTEIN, MARTIN AND CHARLES HORIOKA, 'Domestic saving and international capital flows,' *Economic Journal*, June 1980, **90**: 314–329.

FRANKEL, JEFFREY, 'International capital mobility and crowding-out in the U.S. Economy: Imperfect integration of financial markets or of goods markets?' in Rik Hafer, ed, *How Open is the U.S. Economy?*, Lexington: Lexington Books, 1986.

FRANKEL, JEFFREY, 'Quantifying international capital mobility in the 1980s,' in B. Douglas Bernheim and John B. Shoven, eds, *National Saving and Economic Performance*, Chicago: University of Chicago Press, 1991.

GREENE, WILLIAM H., *Econometric Analysis*, New York: Macmillan Publishing Company, 1993.

MURPHY, ROBERT G., 'Capital mobility and the relationship between saving and investment in OECD countries,' *Journal of International Money and Finance*, December 1984, **3**: 327–342.

OBSTFELD, MAURICE, 'Capital mobility in the world economy: Theory and evidence,' *Carnegie-Rochester Conference on Public Policy*, 1986, **24**: 55–104.

OBSTFELD, MAURICE, 'International capital mobility in the 1990s,' NBER Working Paper No. 4534, November 1993.

OECD, *National Accounts 1960–1990*, Paris: OECD, 1992.

SACHS, JEFFREY D., 'The current account and macroeconomic adjustment in the 1970s,' *Brookings Papers on Economic Activity*: **1**, 1981: 201–268.

SACHS, JEFFREY D., 'Aspects of the current account behavior of OECD economies,' in E. Claassen and P. Salin, eds, *Recent Issues in the Theory of Flexible Exchange Rates*, Amsterdam: North-Holland Publishing Company, 1983.

SHEFFRIN, STEVEN M. AND WING T. WOO, 'Present value tests of an intertemporal model of the current account,' *Journal of International Economics*, November 1990, **29**: 237–253.

SINN, STEFAN, 'Saving-investment correlations and capital mobility: On the evidence from annual data,' *Economic Journal*, September 1992, **102**: 1162–1170.

SPENCER, DAVID F. AND K.T. BERK, 'A limited information specification test,' *Econometrica*, July 1981, **49**: 1079–1085.

SUMMERS, LAWRENCE H., 'Tax policy and international competitiveness,' in Jacob Frendel, ed, *International Aspects of Fiscal Policies*, Chicago: University of Chicago Press, 1988.

TESAR, LINDA L., 'Saving, investment and international capital flows,' *Journal of International Economics*, August 1991, **31**: 55–78.