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Savings, Investment and International Capital Flows

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SAVINGS, INVESTMENT AND INTERNATIONAL CAPITAL FLOWS

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Savings, Investment and International Capital Flows

I. Introduction

Assumptions about the degree of capital mobility between national economies are crucial in the analysis of many problems in international trade and finance. Under the assumption of perfectly integrated financial markets, the world's savings are allocated efficiently as capital flows freely across national borders seeking the highest rate of return. This movement of investment funds brings about an equalization of domestic interest rates as the world's demand for investment and the supply of savings determine the global rate of return to capital. Conversely, if financial markets are not well integrated, rates of return to capital will differ across countries and the rate of domestic investment will be restricted by the amount of national savings.

Empirical evidence on the question of capital mobility is mixed. Cross-country comparisons of domestic rates of return to capital do not generally support the hypothesis of interest rate parity, though problems with defining the risk premium associated with foreign assets and the large standard errors of the econometric tests suggest that the question is still open. The observed high correlation between domestic savings and investment rates has been interpreted as additional evidence that capital is not mobile between national economies.

The purpose of this paper is to examine this correlation between national savings and domestic investment and its implications for capital mobility. Section II provides a brief survey of the literature relating to the savings-investment approach to capital mobility. Basic statistics relating to savings and investment rates in the OECD countries and replications of some conventional savings-investment regressions are presented. The positive correlation between savings and investment rates across countries is found to exist in a sample of 24 OECD countries and is evident in the short- as well as long-run. Thus, the correlation is not an artifact of a particular sample of countries or a particular time period but is a persistent characteristic of savings and investment behavior of the OECD countries.

In Sections III and IV, two small open-economy models are developed which generate co-movements in savings and investment rates in response to certain types of exogenous disturbances. The models demonstrate that such co-movements are consistent with integrated financial markets. In the overlapping generations model with restricted labor mobility (Section III), unanticipated future productivity shocks lead to correlated movements in savings and investment rates. The model of Section IV imposes an additional restriction on trade in investment goods. In this framework, future productivity shocks as well as demand shocks produce co-movements in savings and investment rates when the degree of substitutability between traded and nontraded goods is low. While imperfectly integrated capital markets remains a possible explanation for the savings-investment correlation, these results suggest that there are a variety of alternative explanations. The models also demonstrate that the savings-investment correlation is a natural outcome in a world with some restrictions on international markets. What remains to be tested is whether the relevant barriers apply to trade in goods, factors or financial assets.

II. Evidence on the Correlation between Savings and Investment

The positive correlation between savings and investment rates was first emphasized in a study by Martin Feldstein and Charles Horioka (1980). Their interpretation of the correlation as proof that financial markets are not well integrated prompted a wide debate over the validity of their econometric evidence and its implications for international capital mobility. Subsequent research has verified that the savings-investment correlation is a persistent phenomenon in the OECD countries that cannot be dismissed as an artifact of a particular choice of countries or sample period. The relevance of this correlation for international financial markets, however, is unclear. Recent work with general equilibrium models has shown that, independently of the degree of capital mobility, co-movements in savings and investment may be explained by exogenous distubances to productivity or population growth.

The Feldstein-Horioka Model:

Feldstein and Horioka (1980) assert that with perfect capital mobility, "there should be no relation between domestic savings and domestic investment; saving in each country responds to the worldwide opportunity for investment while investment in that country is financed by the worldwide pool of capital" (p.317).[1] To test for the relationship between savings and investment, the authors run the following regression on a cross-section of 16 industrialized countries: [2]

$$(I/GDP)_i = a + \beta(S/GDP)_i$$

where for each country i:

I = gross domestic investment
S = gross national savings
GDP = gross domestic product.

The ratios of savings and investment to GDP are averaged over the entire sample period of fourteen years (1960-1974) so that each observation represents one country. The sample period is then split into the intervals 1960-64, 1965-69 and 1970-74 and the regression is repeated for the subsamples. In each of the tests the coefficient on savings is found to be in the range of 0.85 to 0.95, insignificantly different from unity. They conclude that 85% to 95% of national savings is invested in the country of origin and reject the hypothesis of perfect capital mobility.

To test the robustness of the result, Feldstein and Horioka examine the possibility that the correlation between savings and investment varies with the degree of openness of the economy, measured as the share of trade in GDP, or with the size of the economy, using the logarithm of GDP as a proxy for size. The linkage between national savings and domestic investment persists in each of these tests. An instrumental variable for savings is then estimated as a function of the growth of private income, the number of retirees and dependents as a share of the total population, the benefit-earnings ratio of the social security program, and the labor force participation rate. Incorporation of this estimate of national savings does not significantly change the results. Overall, Feldstein and Horioka find little support for the hypothesis that savings and investment rates are independent . Even more surprising, Feldstein (1983) finds no evidence that the correlation between savings and investment has weakened over time.

The difference between savings and investment, interpreted by Feldstein and Horioka as an indicator of capital mobility, is the current account in the balance of payments. In two papers, Sachs (1981, 1983) examines fluctuations in the current account balances of LDC and OECD economies since 1960. Sachs approaches the savings-investment relationship from a different perspective: he regresses the balance on the current account on national savings and domestic investment and finds that investment is more closely correlated with shifts in the current account. He concludes that "variations in investment demand have dominated the medium-run behavior of current accounts and exchange rates in the 1970s" (Sachs 1981, p.203). Though the causal links between savings, investment and the balance on the current account are ambiguous, the regressions do establish that there is a significant correlation between investment and the balance on current account.[3]

The implications of the Feldstein-Horioka study and the investment-current account linkage reported by Sachs encouraged a number of other researchers to try to pin down the relationships between national savings, domestic investment and the current account. Penati and Dooley (1984) confirm the Feldstein-Horioka results but find the regressions reported by Sachs to be heavily dependent on one or two outlying observations and the coefficients to be sensitive to the choice of time period. Based on their own regression analyses, Penati and Dooley reaffirm that "the data clearly lead one to reject the hypothesis that changes in net foreign assets have become more sensitive to yield differentials" (p.9).

Rather than averaging the data over long periods, Caprio and Howard (1984) focus on the medium run which they define as the period from one business cycle to the next. Observations of savings, investment and the balance on the current account for 23 OECD countries are averaged from trough to trough of the four business cycles in the 1961-81 period (1963-66, 1967-70, 1971-74 and 1975-81). To avoid the problem of endogenous right hand side variables, the original Feldstein and Horioka equation is rewritten as:

$$\frac{\Delta (CA/Y)}{\Delta (S/Y)} = \mu + e$$

where μ is the average of $[\Delta (CA/Y) / \Delta (S/Y)]$ over the relevant business cycle and Y is the level of GDP. The coefficient μ for the sample of all countries is estimated at 0.450 with a standard error of 0.115. Caprio and Howard conclude that "only about half of any change in domestic savings was matched by changes in domestic investment in the medium run.....[C]ontrary to the conclusions of Feldstein and Horioka and others, there is a large degree of net medium-term capital mobility in the world economy" (p.15). The authors repeat the regressions using the ratio of changes in the current account to changes in investment. In contrast to Sachs' results, they report that "fluctuations in savings were more systematically associated with current account developments than were variations in domestic interest rates" (p.15). Caprio and Howard are careful to point out that their conclusions differ from the Feldstein and Horioka study due to the use of changes in saving and investment over time. When the regressions are repeated with levels of saving and investment, the coefficients are nearly identical to those in the original paper.

Using the monetary approach to the balance of payments, Turner (1986) estimates excess savings rates (savings less investment) as a function of income, the real interest rate and the real exchange rate for the seven largest industrialized countries. The current account is then regressed on the "fitted" excess savings equations for each of the countries. The estimated equations are relatively poor predictors of changes in the current account, though it is unclear whether this is a weakness of the savings-investment approach or a peculiarity of Turner's model and its assumptions about savings and investment behavior.

Tests of the Savings-Investment Correlation

To clarify the discussion of the co-movements in savings and investment rates and the current account, this paper presents some basic statistics describing these aggregates and reproduces the savings-investment regressions for a sample of 24 OECD countries. The data used are the annual series in the Main Aggregates volume of the National Accounts of OECD Countries, published by the OECD. Domestic investment and national savings are reported as net rather than gross figures as the net figures are more manageable and the inclusion of depreciation does not change the relative magnitudes of savings and investment as shares of GDP. Twelve of the OECD countries report nonzero values for the statistical discrepancy in their balance of payments,

$$S - I + STATDISC = BCA$$

where BCA equals the balance on current account. In these cases, the statistical discrepancy is split between net savings and investment so that the identity containing only the three aggregate variables, S, I and BCA, holds exactly across all countries.[4]

The figures in Table 1 and Plot 1 confirm the results generally reported in the literature; countries with high savings rates tend to have high investment rates. Throughout the 1960-84 period Japan occupied the high saving-high investment end of the spectrum. The United States and the United Kingdom tended to be relatively low savers and investors. The balance on current account is a smaller share of GDP than either national savings or domestic investment for all countries except Luxembourg. Contrasting the 1960-74 period with the 1975-84 period, the balance on current account is larger in absolute magnitude for 18 of the 24 countries in the latter period, implying that the relationship between savings and investment may have weakened over time.

(Table 1)

Plot 1 graphs the share of net investment in GDP against the share of net savings in GDP. Observations along a 45-degree line (not drawn) indicate that the country's current account is balanced. Observations above the line reflect a deficit in the country's current account; that is, the country's domestic investment exceeds its supply of national savings and the country is a net borrower in the international capital market. Greece and Ireland are examples of countries that have typically had negative current account balances, while Luxembourg appears to have had an excess of national savings over domestic investment.

(Plot 1)

It is clear by visual inspection of Plot 1 that there is a positive correlation between savings and investment rates and that a regression line through these points would yield a regression coefficient somewhere close to unity. Replication of the savings-investment regression for the sixteen countries included in the Feldstein-Horioka study, with the cross-section observations measured over the same interval used in their study (1960-74), yields a coefficient on S/GDP of 0.93 with a t-statistic of 9.13 (see Table 2). The estimate of the constant is 1.67, larger than that reported by Feldstein and Horioka. The cross-country correlation between I/GDP and S/GDP appears to be much weaker for the sample of 24 countries over the period 1960-84. This turns out to be an artifact of the inclusion of Luxembourg in the sample. (That Luxembourg is an extreme outlier can be seen from Plot 1.) When Luxembourg is dropped from the sample, the coefficient on S/GDP is once again insignificantly different from unity, regardless of the time interval used to calculate the averages.

(Table 2)

The cross-country correlation between savings and investment persists even as the period over which the averages are calculated is shortened. Table 3 shows regression results for five-year and three-year averages and single-year estimates. The coefficient on savings is insignificantly different from unity at the 0.025 level of significance throughout the sample except for a period in the late 1960s- early 1970s. This suggests that the savings-investment correlation is a short- as well as long-run phenomenon in cross-section samples and is not merely an artifact of averaging over long intervals.

(Table 3)

Table 1: **Savings, Investment and the Current Account as a percentage of GDP:**

Country	1960-1984 S/GDP	I/GDP	BCA/GDP
Canada	9.9	11.1	-1.2
France	13.1	13.3	-0.3
Germany	14.4	13.7	0.6
Italy	13.5	13.3	0.5
Japan	21.2	20.6	0.6
United Kingdom	8.8	8.9	-0.1
United States	7.6	7.5	0.1
Australia	15.6	18.0	-2.4
Austria	15.2	15.7	-0.5
Belgium	11.8	11.9	-0.2
Denmark	12.8	15.3	-2.6
Finland	12.4	14.0	-1.7
Greece	16.1	18.8	-2.7
Iceland	12.6	15.6	-3.1
Ireland	10.6	15.6	-5.0
Luxembourg	26.9	12.9	13.9
Netherlands	15.8	14.7	1.1
New Zealand	14.9	17.6	-2.7
Norway	13.0	15.3	-2.3
Portugal	19.4	22.5	-3.1
Spain	12.8	13.4	-0.6
Sweden	11.5	12.1	-0.7
Switzerland	18.6	17.0	1.6
Turkey	11.2	13.4	-2.2

Country	1960-1974 S/GDP	I/GDP	BCA/GDP	1975-1984 S/GDP	I/GDP	BCA/GDP
Canada	10.4	11.5	-1.1	10.5	9.2	-1.4
France	15.4	15.3	0.1	10.5	9.5	-1.0
Germany	17.4	16.6	0.9	9.5	9.8	0.3
Italy	15.6	14.5	1.0	10.8	10.4	-0.4
Japan	22.9	22.4	0.5	17.8	18.6	0.8
United Kingdom	10.2	10.7	-0.4	6.2	6.5	0.3
United States	9.1	8.7	0.4	5.6	5.7	-0.3
Australia	16.7	18.5	-1.8	17.2	13.9	-1.2
Austria	16.7	16.8	-0.4	14.0	12.9	-1.2
Belgium	13.9	13.0	1.0	10.4	8.5	-1.9
Denmark	16.2	18.2	-2.0	11.0	7.6	-3.4
Finland	14.1	15.7	-1.6	11.4	9.7	-1.7
Greece	16.7	19.6	-2.9	17.5	15.2	-2.3
Iceland	14.2	16.8	-2.7	13.9	10.3	-3.6
Ireland	11.8	14.6	-2.8	17.1	8.9	-8.2
Luxembourg	21.3	13.1	8.3	12.7	35.2	22.4
Netherlands	18.4	17.6	0.8	10.5	11.9	1.5
New Zealand	14.5	16.0	-1.5	20.0	15.4	-4.5
Norway	13.9	16.0	-2.1	14.3	11.8	-2.5
Portugal	20.7	21.0	-0.3	24.9	17.5	-7.4
Spain	14.3	14.4	-.-	11.9	10.5	-1.4
Sweden	14.6	14.5	0.1	8.6	6.8	-1.8
Switzerland	19.7	19.7	-.-	12.9	16.9	3.9
Turkey	10.6	11.6	-1.1	16.0	12.0	-4.0

Plot 1: S/GDP vs I/GDP for 24 Countries

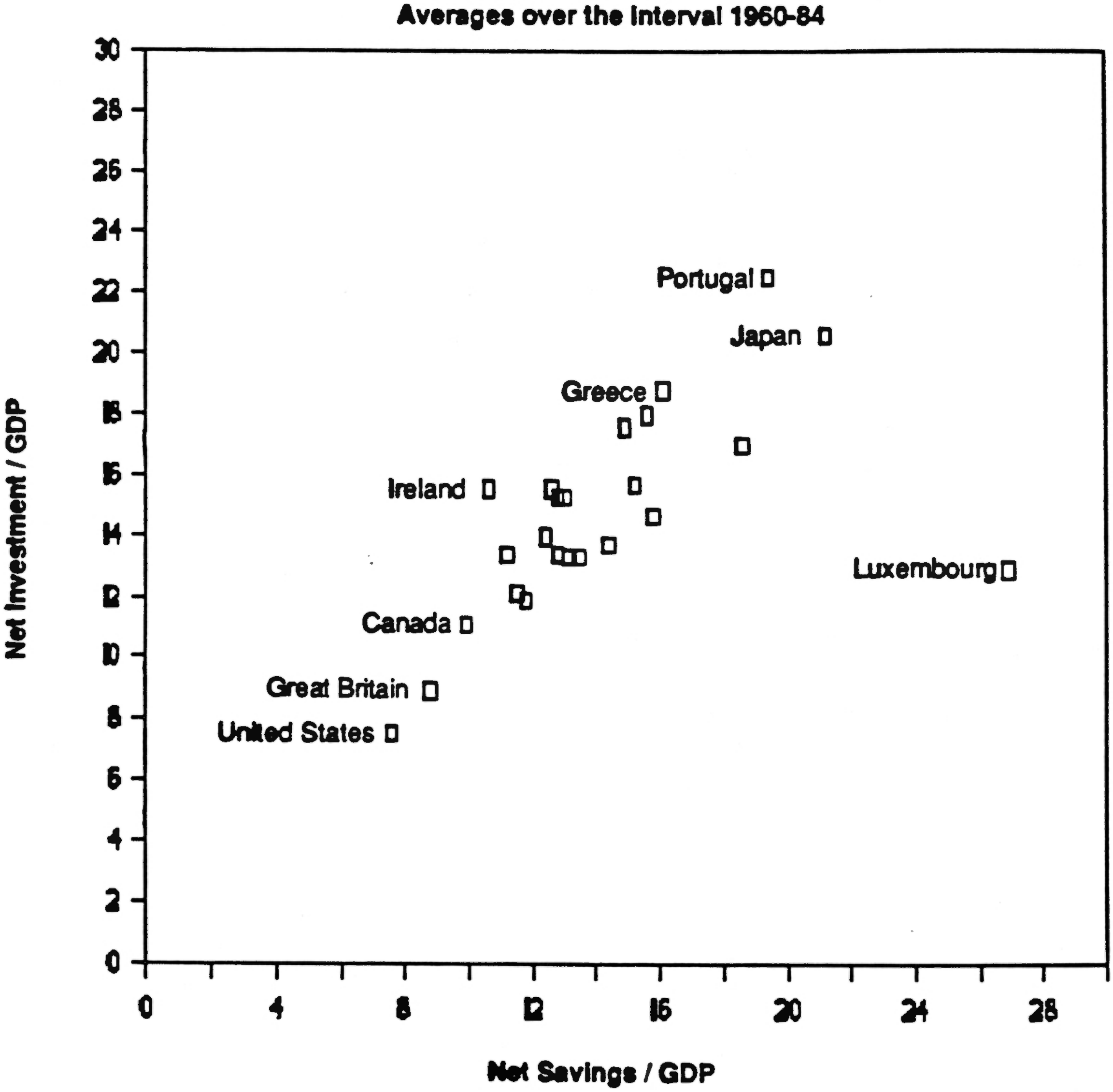


Table 2 : Cross-Section Regressions of Net Savings/GDP on Net Investment/GDP
(figures in parenthesis are standard errors)

$$I/GDP = a + b\,(S/GDP)$$

Period	intercept a	estimate of b	adj R^2
24 country sample:			
1960-84	7.80 (2.03)	0.49 (0.14)	0.36
1960-74	4.29 (1.89)	0.741 (0.12)	0.62
1975-84	9.02 (1.89)	0.36 (0.14)	0.17
16-country sample			
1960-84	1.91 (1.78)	0.93 (0.13)	0.77
1960-74[a]	1.67 (1.58)	0.93 (0.10)	0.84
1975-84	1.89 (1.93)	0.98 (0.17)	0.68
23-country sample (excludes Luxembourg)			
1960-84	2.11 (1.51)	0.93 (0.11)	0.77
1960-74	2.03 (1.22)	0.91 (0.08)	0.86
1975-84	1.81 (1.91)	1.00 (0.16)	0.63

a. Identical to the sample of countries and time period of the Feldstein-Horioka study.

Table 3: **Evidence from Cross-Section Regressions of the Short-Run Correlation between Savings and Investment** (figures in parentheses are standard errors)
Sample includes 23 OECD countries -- Luxembourg excluded from the sample.

Period	intercept a	estimate of b	adj R^2
A. Five-year intervals			
1960-64	1.55 (1.22)	0.95 (0.08)	0.85
1965-69	3.73 (1.55)	0.79* (0.10)	0.73
1970-74	2.78 (1.54)	0.87 (0.10)	0.80
1975-79	3.02 (2.40)	0.91 (0.19)	0.51
1980-84	2.60 (1.76)	0.93 (0.16)	0.60
B. Three-year intervals			
1960-62	2.07 (1.41)	0.90 (0.10)	0.80
1963-65	1.66 (1.29)	0.95 (0.09)	0.85
1966-68	4.18 (1.73)	0.76* (0.11)	0.66
1969-71	2.94 (1.42)	0.83* (0.09)	0.80
1972-74	2.91 (1.76)	0.87 (0.10)	0.76
1975-77	4.60 (3.00)	0.82 (0.23)	0.34
1978-80	2.30 (1.71)	0.95 (0.13)	0.69
1981-83	2.47 (1.88)	0.95 (0.18)	0.56
1984-85	1.69 (0.85)	0.75 (0.16)	0.50

Table 3: (continued)

Period	intercept	estimate of b	adj R^2
C. Point-in-time estimates			
1960	2.98 (1.54)	0.84 (0.10)	0.74
1962	1.70 (1.53)	0.92 (0.11)	0.78
1964	1.17 (1.49)	0.99 (0.10)	0.83
1966	3.62 (1.60)	0.81* (0.10)	0.73
1968	5.14 (1.93)	0.67* (0.13)	0.54
1970	2.07 (1.57)	0.90 (0.09)	0.80
1972	3.07 (1.18)	0.77* (0.07)	0.85
1974	7.01 (3.35)	0.74 (0.22)	0.33
1976	5.47 (2.92)	0.75 (0.22)	0.33
1978	1.14 (2.03)	0.97 (0.16)	0.63
1980	3.79 (1.63)	0.89 (0.13)	0.68
1982	2.84 (2.05)	0.96 (0.20)	0.50
1984	3.37 (1.70)	0.75 (0.16)	0.50

* coefficient is significantly different from 1.0 at the 0.025 level of significance.

Accounting for the Correlation between Savings and Investment

The evidence clearly suggests that there is an important link between national savings and domestic investment. The implications of this relationship for international capital mobility, however, are not obvious. Several problems with this approach suggest that the high correlation between savings and investment is not inconsistent with integrated financial markets.

Sample Bias

An important criticism of the Feldstein-Horioka study is that the inclusion of only large industrialized countries in the sample may cause an upward bias in the estimated correlation between savings and investment. Harberger (1980) compares the investment and savings to income ratios of a country with that of a city block; the level of investment on a given block will typically exceed the saving's capacity of the block's residents. However, as the level of aggregation rises to the city, state and national levels, the divergence between "local" investment and "local" savings will decrease. A regression of savings on investment for a large state would probably reveal that most savings remained within state borders -- though this hardly proves that financial markets within the United States are not well integrated. Thus, Harberger conjectures that small and poor countries will experience larger capital flows in and out of their borders than will larger industrialized countries. Sachs (1983) confirms that the absolute magnitude and the variability of the ratio of the current account to GNP is negatively related to size. Further, the inclusion of small countries (in terms of GDP) in the sample tends to weaken the savings-investment correlation (Murphy,1984). When the sample is split, the correlation between savings and investment is significantly weaker for developing countries than for industrialized countries (Dooley, Frankel, and Mathieson, 1987). In the sample of 24 OECD countries studied in this paper, the standard deviation of the current account relative to GDP is lower (on average) for the largest seven countries, although there appears to be less variability in savings and investment rates for these countries as well (see Table 4).

(Table 4)

The issue of country size is compounded by the small open economy assumption implicit in the analyses. A country with a large share of world output is also likely to have a relatively large share of the world's total savings and investment. Small countries take the world interest rate as given, while changes in the investment and savings behavior of large countries will have an impact on the world interest rate. Feldstein and Horioka admit that even with perfect capital mobility, the correlation coefficient between S/GDP and I/GDP will not approach zero, though they dismiss this bias as negligible. When the original sample of 16 OECD countries is split into two groups by size, Murphy is able to reject the hypothesis that the groups exhibit the same relationship between savings and investment. [5]

Table 4: **Variability of Saving, Investment and the Current Account as shares of GDP** (standard deviations for the period 1960-1984)

	SGDP	IGDP	BCA/GDP
Canada	1.84	2.18	1.12
France	3.33	2.81	1.08
Germany	4.06	4.01	1.05
Italy	3.11	2.85	2.05
Japan	2.80	3.13	1.16
United Kingdom	2.32	2.67	1.46
United States	2.39	2.10	0.76
Group Avg.	(2.84)	(2.82)	(1.24)
Australia	2.19	1.70	1.80
Austria	2.40	2.39	1.22
Belgium	3.74	2.50	1.96
Denmark	4.70	4.13	1.23
Finland	2.59	3.45	1.84
Greece	4.27	3.95	1.41
Iceland	3.69	4.06	3.96
Ireland	3.05	3.06	4.16
Luxembourg	8.85	3.75	9.32
Netherlands	3.43	3.88	1.73
New Zealand	2.31	3.96	3.40
Norway	2.37	3.35	4.43
Portugal	5.37	4.21	5.29
Spain	2.72	3.15	1.97
Sweden	4.38	3.62	1.46
Switzerland	1.60	3.79	2.70
Turkey	2.34	2.98	2.03
Group Avg.	(3.53)	(3.41)	(2.93)

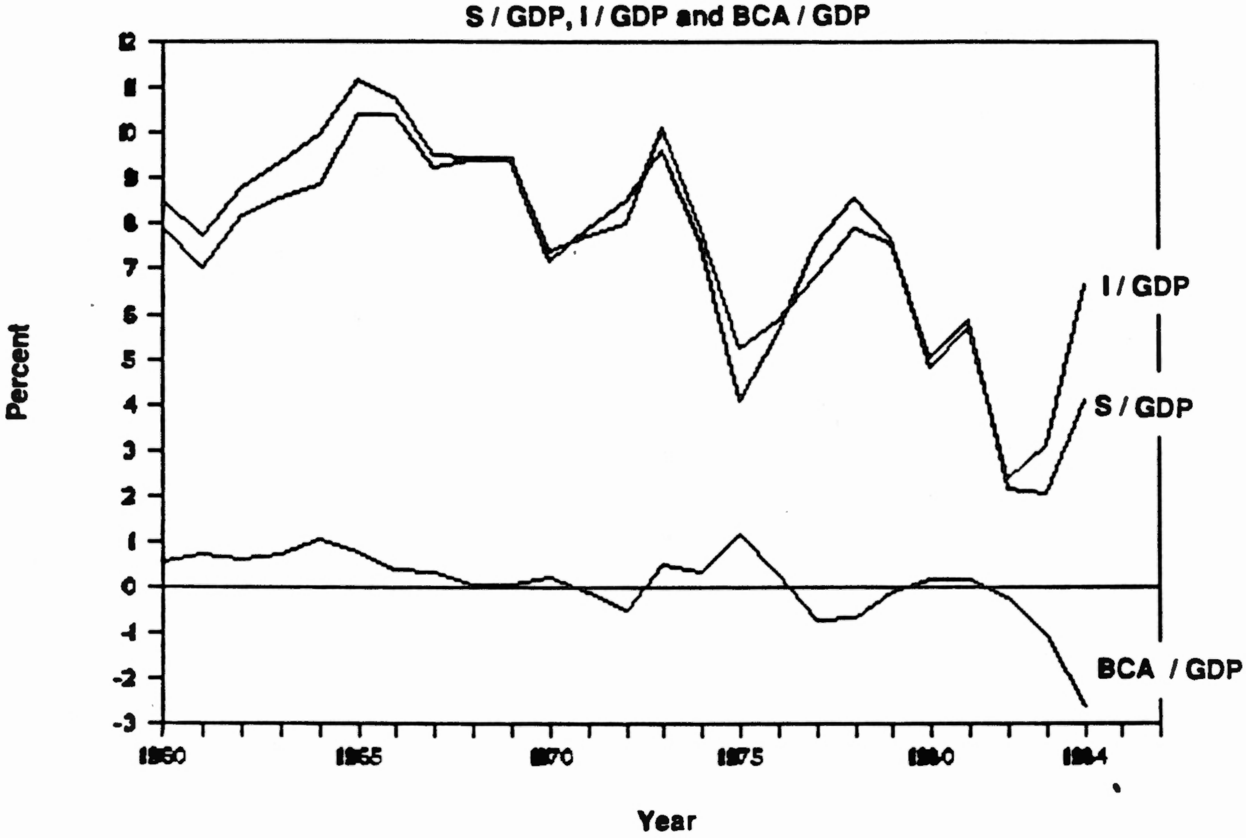
Correction for the bias due to country size, however, still leaves a significant correlation between savings and investment (Fieleke, 1982). As discussed above, repeated regressions using the full set of OECD countries averaged over different sample periods indicates that the savings-investment correlation persists and cannot be dismissed merely as an artifact of country-size bias. Within the set of OECD countries, small as well as large countries exhibit a significant correlation between savings and investment rates over time.

To establish a "benchmark" for measuring capital mobility, Murphy estimates the relationship between savings and investment for the 143 largest corporations in the United States and finds that even within a highly integrated capital market, firms' savings and investment rates are highly correlated. There also appears to be a firm-size effect on savings and investment behavior: the coefficient on savings is significantly higher for large corporations than for small firms. This evidence is cited as additional support for the existence of bias due to country-size, though the direct applicability of results based on firms' behavior to cross-country analysis is questionable. The correlation between savings and investment for firms implies that firms use unexpected profits to finance their own investment projects rather than distribute these profits as dividends to shareholders. For a variety of reasons studied in the theory of corporate finance (sée the survey by Litzenberger and Ramaswami, 1982), it may be optimal for managers to retain to retain unexpected profits for investment instead of utilizing the capital market. These reasons would seem to be quite different from those factors determining savings and investment rates for the country as a whole.

The correlation between S/GDP and I/GDP is apparent within national economies over time, as well as across the sample. Plots 2 through 4 show the time series plots of net savings and investment and the balance on current account as shares of GDP for the United States, Germany and Japan. In all three countries, there was considerable range in the levels of savings and investment over time (approximately 10 percentage points) but less variation in the difference between the two series. Plots 5 through 7 show scatter diagrams of S/GDP plotted against I/GDP for the same three countries. The observations in the scatter plots roughly trace out the 45-degree line, indicating relatively small changes in the balance on current account despite the large changes in savings and investment over time. Thus, the evidence suggests that savings and investment rates are closely linked not only <u>on average</u> across countries, but also <u>within</u> some countries on a year-by-year basis.[6]

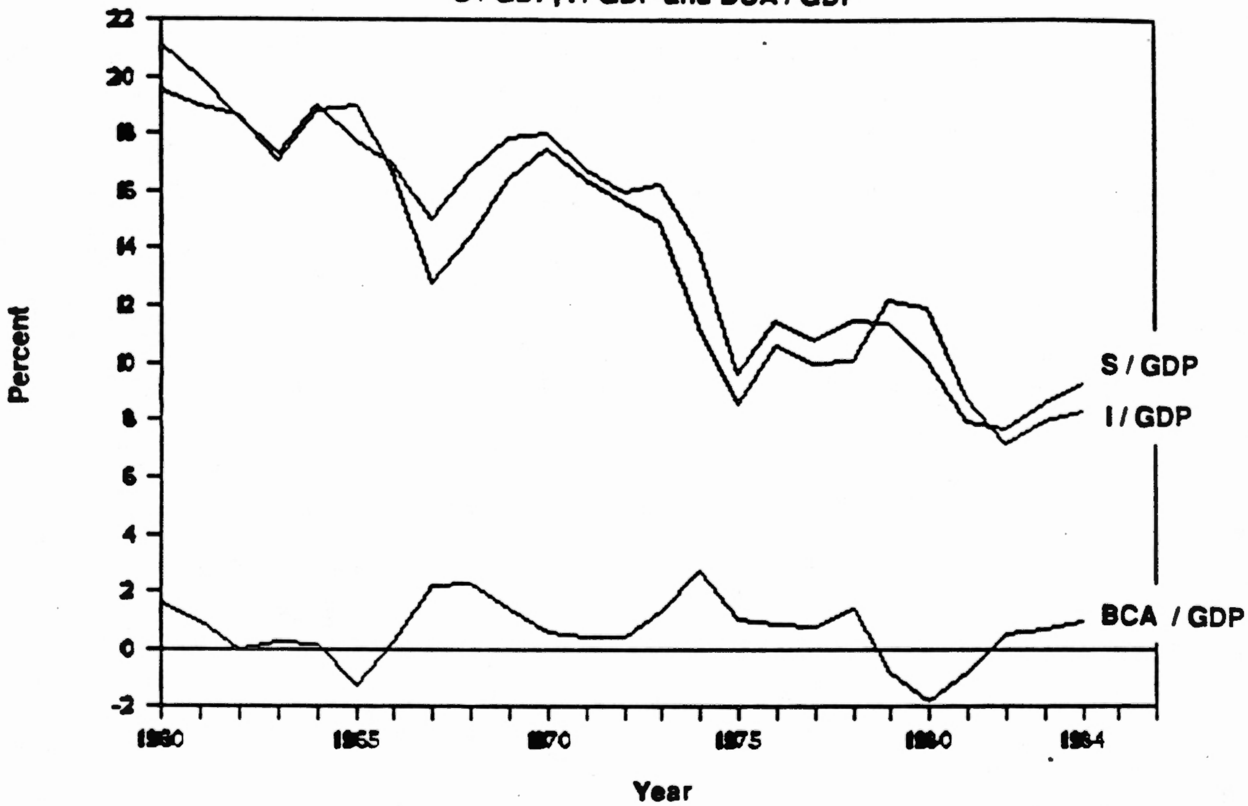
(Plots 2 - 7)

Plot 2: UNITED STATES - 1960-84



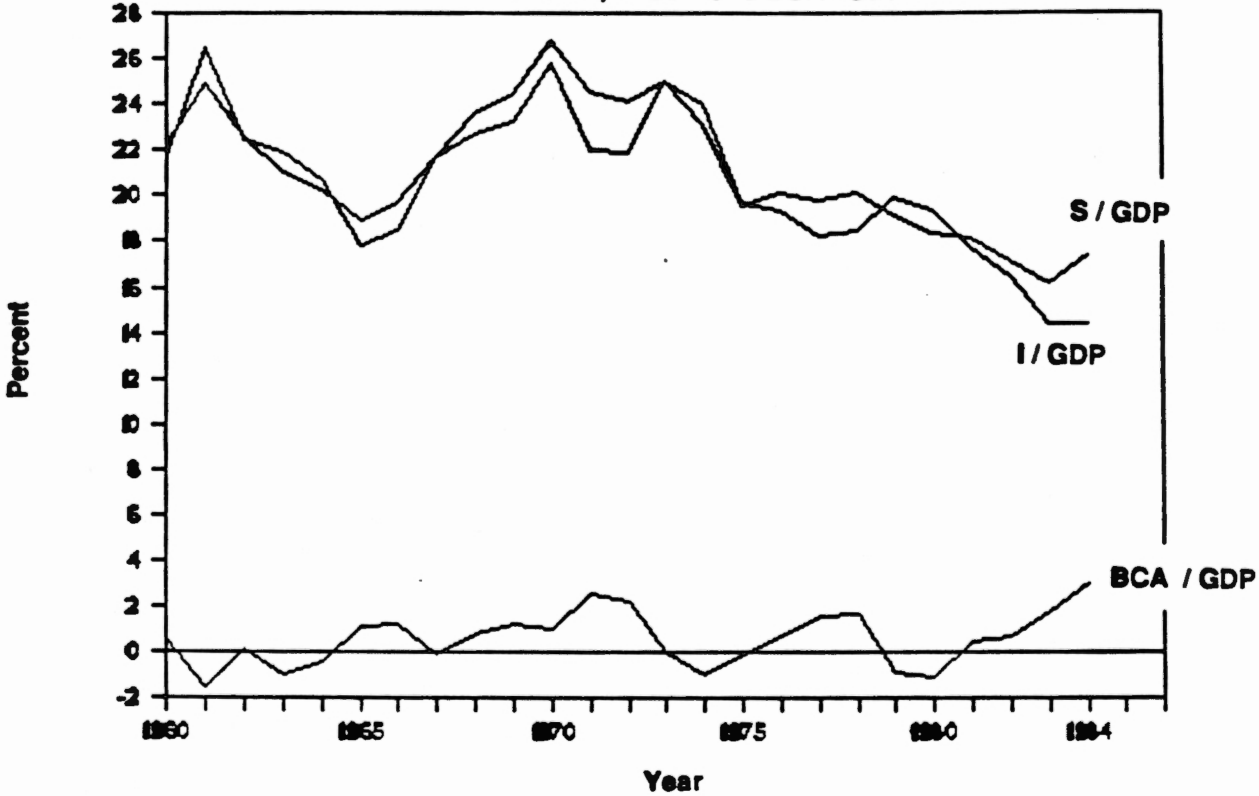
Plot 3: WEST GERMANY - 1960-84

S / GDP, I / GDP and BCA / GDP



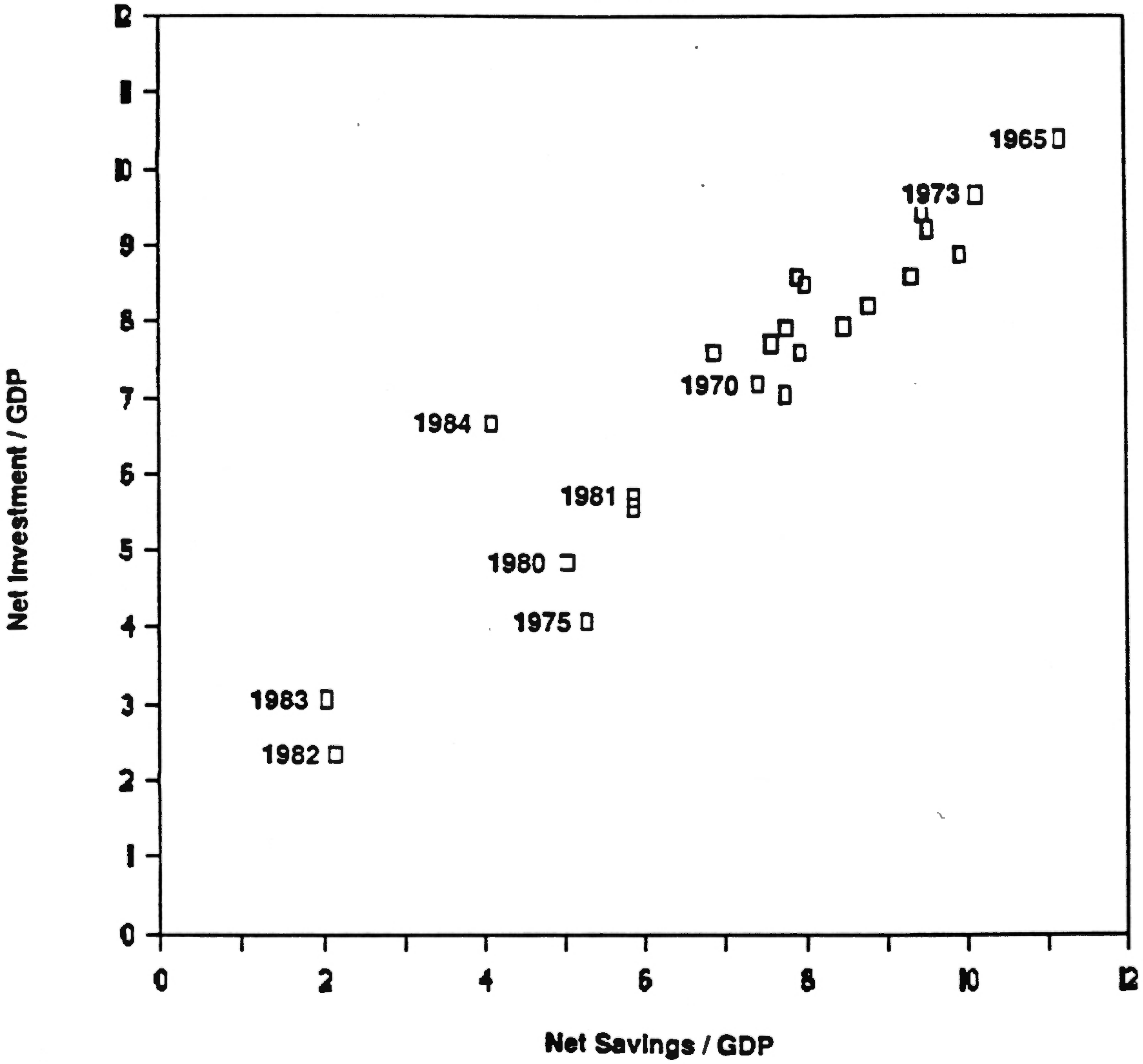
Plot 4: JAPAN - 1960-84

S / GDP, I / GDP and BCA / GDP

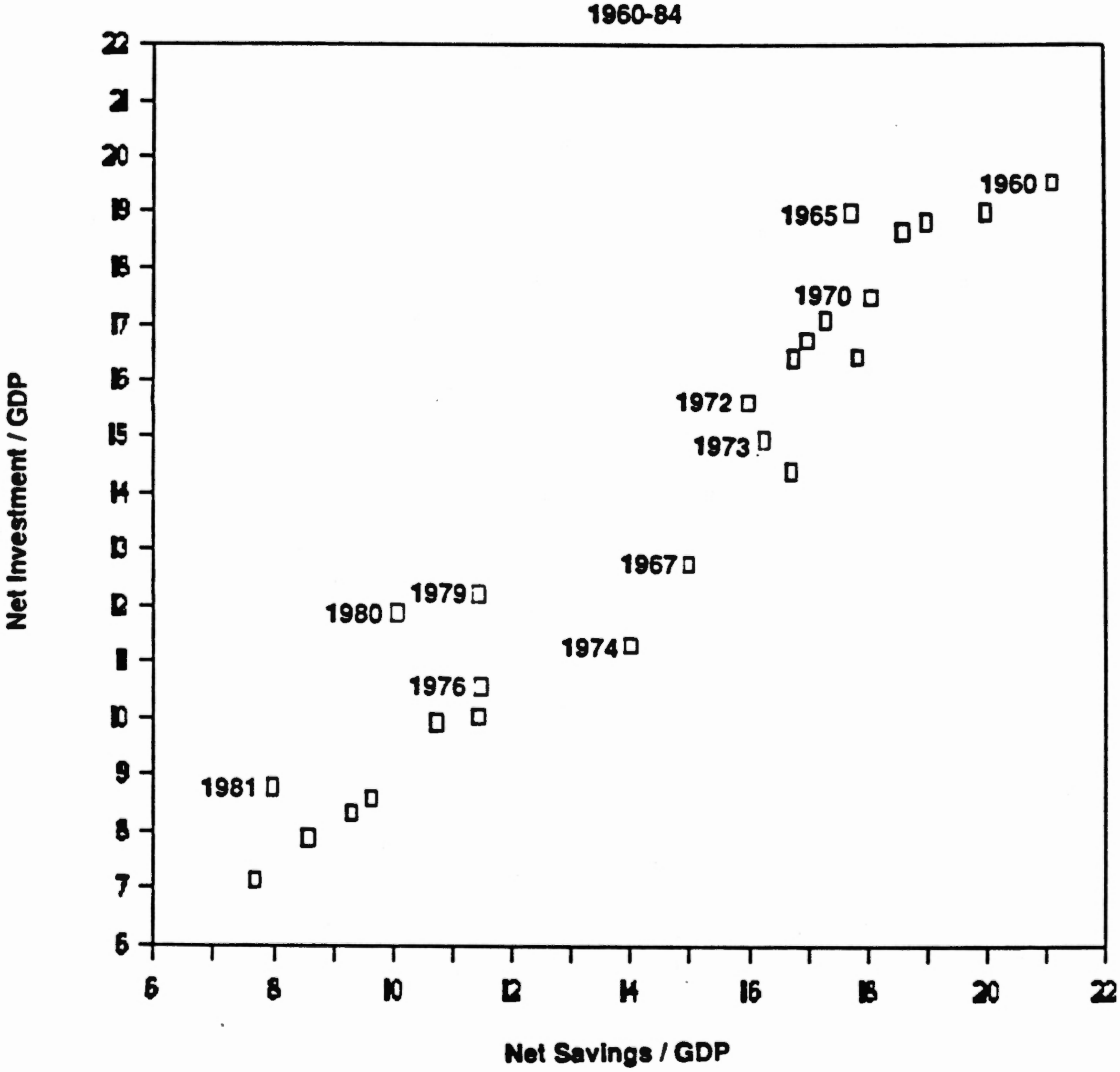


Plot 5: S/GDP vs I/GDP, UNITED STATES

1960-84



Plot 6: S/GDP vs I/GDP, WEST GERMANY



Capital Controls and Government Policy:

Westphal (1983), Summers (1985) and others have suggested that the observed high correlation between savings and investment rates is evidence of a successful balance-of-payments policy on the part of national governments. They argue that governments impose constraints on cross-border capital flows whenever the deficit (or surplus) in the current account exceeds a predetermined level. Capital controls are undoubtedly an important policy instrument in balance-of-payments management, particularly under a system of fixed exchange-rates. However, the strength of the correlation between savings and investment rates has not diminished despite the widespread consensus that capital markets have become less restricted over time. The regression results shown in Table 2 do not support the hypothesis that the savings-investment correlation is linked to the exchange rate regime, although more careful testing of this hypothesis is required to draw any firm conclusions.

Governments can also affect the current account by adjusting the savings and investment rates of the public sector. There is some cross-country evidence that changes in government savings are matched by offsetting changes in private savings and investment such that the balance on current account is relatively constant (Soderstrom, 1985). One explanation is that government policy responds to shifts in private behavior to maintain a target level in the current account. An alternative interpretation incorporates the Ricardian view of private and government saving: forward-looking agents will internalize the government's budget constraint and adjust their own behavior to offset changes in government policy. Tests of variance decomposition and Granger causality may help to distinguish between these two hypotheses.

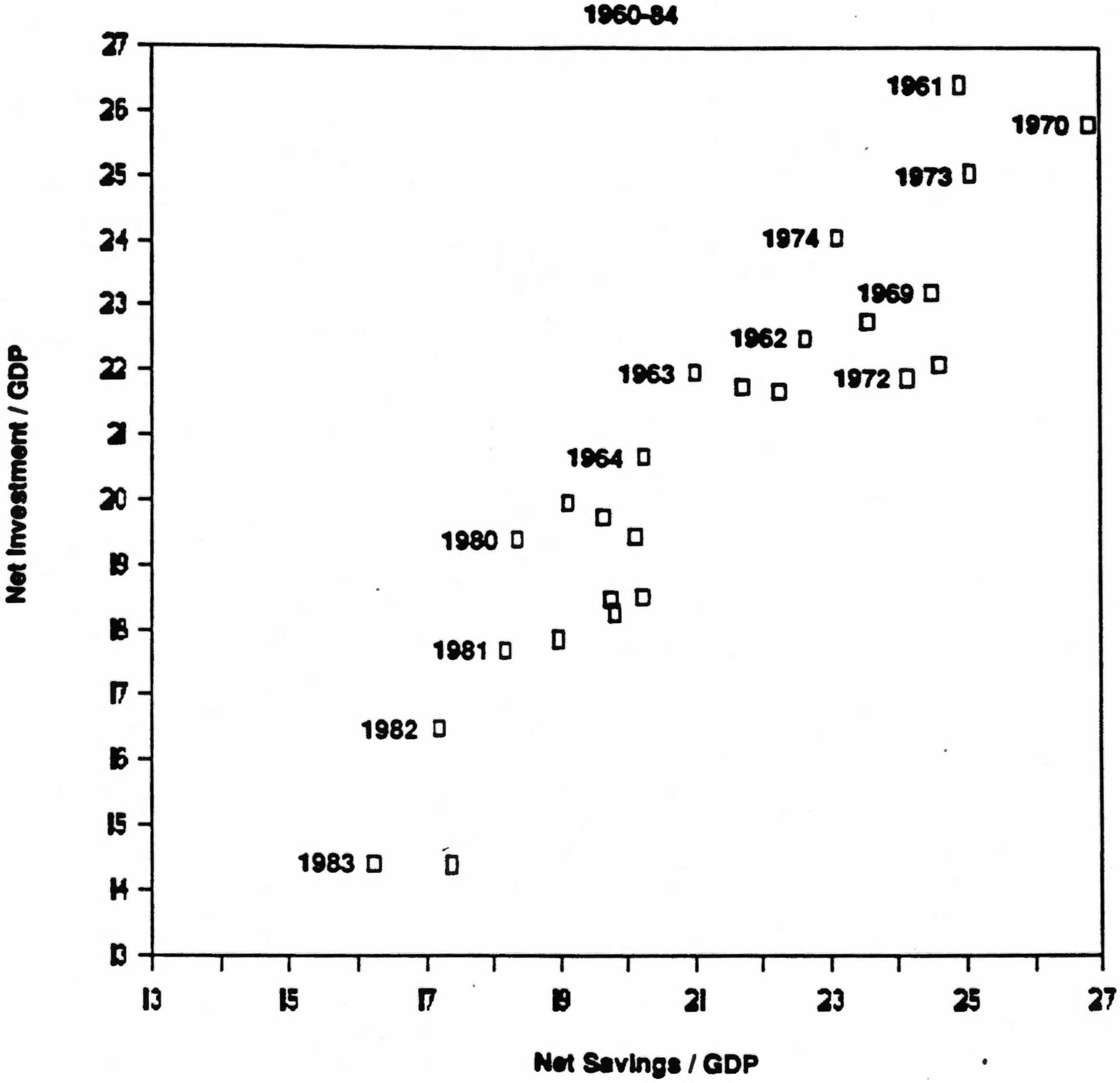
Restrictions on Capital Flows or Goods Markets?

Savings, investment and the balance on the current account are part of an identity linking the domestic economy to the rest of the world through the balance of payments. Ex post, it is necessarily true (abstracting from statistical discrepancies) that the difference between national savings and domestic investment (or equivalently, the difference between imports and exports) must equal the balance on the current account:

$$\begin{aligned} CA &= Y - (C + I^P + G) \\ &= (S^P + S^G) - (I^P + I^G) \\ &= M - X \end{aligned}$$

where Y equals disposable income plus taxes and the variables with superscripts P and G denote savings and investment of the private sector and government. This identity stems from the definitions used in national income accounting; it is <u>not</u> a behavioral relationship linking the national aggregates. On the surface, the correlation between savings and investment implies that the balance on the current account must be fairly stable over time. But the accounting aggregates in the identity reflect all the flows of

Plot 7: S/GDP vs I/GDP, JAPAN



goods, services and factors of production between the domestic economy and the rest of the world. The strong correlation between savings and investment could be the result of any of a number of forces at work in the national or international economy. Without an explicit model underlying the above identity, it is difficult to draw any conclusions from the regression analyses.

Frankel (1985) argues that markets are segmented due to imperfect integration of the goods market; that is, the goods market, not the capital market, is the binding constraint linking savings and investment rates. If some goods are nontraded, or "immobile", some of the channels connecting national economies are closed off and the economy behaves more like a "closed" economy. Cole and Obstfeld (1988) show that under certain conditions, trade in goods in the absence of trade in financial markets can achieve the same degree of risk-pooling as if there had been exchange of financial assets. When all commodities, including goods that can be used for consumption or investment by the foreign country, are exchanged, trade in goods may be sufficient for complete risk-pooling. In this model, changes in the terms-of-trade are sufficient to balance trade in every period making trade in financial claims unnecessary for intertemporal smoothing.

As nontraded goods and immobile factors are introduced into these models, the level of domestic investment becomes increasingly limited by the supply of national savings. Engel and Kletzer (1987) demonstrate this point using a model with a nontraded labor-intensive consumption good. In this model, an exogenous increase in the savings rate lowers consumption of the nontraded good. As more labor than capital is released into the economy, the marginal product of capital in the traded good industry rises and investment increases. Thus, a change in the savings rate leads to a roughly contemporaneous change in the investment rate. The models presented in Section IV of this paper consider productivity and demand shocks in a similar model with a nontraded goods sector. A general feature of these models is that virtually any shock to the nontraded goods sector leads to co-movements in savings and investment rates. To the extent labor is mobile within the domestic economy, these shifts in savings and investment are accompanied by inter-industry movements of labor between the sectors producing the traded and nontraded goods.

Alternative Hypotheses

Recently, attention in the literature has shifted from attempts to explain the savings-investment correlation as a result of imperfect markets to developing models which produce the correlation in response to exogenous disturbances. Obstfeld (1985) was the first to break ground in this direction. Using a framework with an infinitely-lived representative agent, Obstfeld demonstrates that underlying shocks to productivity may generate co-movements in savings and investment. A (positive) temporary shock causes the current wage to rise above the permanent wage, increasing the savings rate. If the shock is sufficiently persistent, investment will rise to take advantage of the higher (future) level of productivity. The model is limited by the high degree of consumption smoothing and intertemporal substitution implicit in the infinite-horizon set-up; the shock must be temporary enough to induce an increase in savings, and sufficiently persistent to stimulate an increase in investment.

The adoption of overlapping generations introduces a finite planning horizon into the model in an analytically tractable way. Consumers are usually assumed to work in the first period of their lives and save out of their wages for consumption in the second period. In these models, the degree to which the shocks are anticipated matters for the co-movements in savings and investment, rather than the duration of the shock. Persson and Svensson (1985) derive the responses of savings and investment to a terms-of-trade shock in a one-good model with nontraded capital goods. The current account adjusts cyclically to the price change; the change in the terms of trade alters the real rate of return to domestic capital, which leads to a change in the investment rate. The savings rate then responds, with a lag, to the change in the capital stock. The magnitude and direction of these swings in the current account depend critically on the degree to which the shock is anticipated and the assumption about the length of time required for investment.

Obstfeld (1985) uses an overlapping generations model to emphasize the importance of population growth. An increase in the number of workers in the economy increases the level of aggregate savings and stimulates investment to maintain the steady-state capital-labor ratio. To test this hypothesis, Table 5 shows the relationship between the share of the population between the ages of 15 and 64 (roughly the working age population) and the savings and investment rates for the OECD countries included in the Feldstein-Horioka sample and seven non-OECD countries. Countries with a higher percentage of the population of working age tend to have higher savings and investment rates. Regression results for the set of 23 OECD countries are shown in Table 6. It appears that the size of the working age population is more closely correlated with the savings rate than with the investment rate. Explanations based on changes in population growth, however, are restricted to the very long-run co-movements between savings and investment and do not shed much light on the observed short-run links between savings and investment.

(Tables 5 and 6)

The overlapping generations models discussed above measure the reponse of savings and investment rates to a permanent exogenous disturbance. Finn (1987) adds uncertainty to this type of model and produces time series for savings and investment rates under different assumptions about the degree of autocorrelation in shocks to technology . Positively autocorrelated shocks generate patterns of savings and investment which replicate the high correlation between savings and investment observed in the data. The real business cycle literature (see, for example, Prescott, 1986) suggests that for the United States, the underlying shocks to technology, or the Solow residuals, are in fact strongly positively correlated.

The models developed in Sections III and IV of this paper pursue this vein of research by explaining co-movements in savings and investment as a response to exogenous disturbances,

Table 5: **Ratios of Savings and Investment to GDP and Population of Working Age** (1968-84 period)

	Group Averages: % of Pop. ages 15 - 64	S/GDP	I/GDP
Feldstein-Horioka Sample			
Group 1: Japan, Sweden, Finland, Italy, Germany	65.7	26.9	28.1
Group 2: Greece, Denmark, United Kingdom, Belgium, Austria, Australia	63.7	24.1	24.0
Group 3: Netherlands, United States, Canada, New Zealand, Ireland	60.5	22.0	23.0
Non-OECD: Taiwan, Brazil, Hong Kong, India, Kenya, Singapore, Thailand	54.6	17.0	20.1

Source: World Tables, World Bank, 1984.

Table 6: **Regression of S/GDP, I/GDP and share of Population ages 15-64** (23 OECD countries, 1968-84 period)

$$I/GDP = \underset{(1.67)}{2.18} + \underset{(0.12)}{0.93}\, S/GDP \qquad \text{Adj. } R^2 = 0.72$$

$$S/GDP = \underset{(16.67)}{-8.69} + \underset{(0.26)}{0.34}\, POPW \qquad \text{Adj. } R^2 = 0.03$$

$$I/GDP = \underset{(18.90)}{17.97} - \underset{(0.30)}{0.05}\, POPW \qquad \text{Adj. } R^2 = -0.05$$

Figures in parentheses are standard errors.

independently of the degree of capital mobility. It will be shown that co-movements in savings and investment are a more general result than the papers discussed above might imply. In each of the models, individuals have access to international financial markets; that is, savers can hold foreign assets in their portfolios and investors can borrow from foreign lenders. The first model adopts an overlapping generations framework and highlights the distinction between anticipated and unanticipated distubances to productivity. A nontraded capital good is introduced into the second model. In this framework, demand as well as supply shocks can produce a correlation between savings and investment.

III. Savings and Investment in an Overlapping Generations Model

In this section, I will develop a small open economy that produces a single good for consumption and trade. To focus on intertemporal substitution in consumption and production, I assume that there is only one good in the world economy. Individuals in the economy have two-period lives: savings out of their first-period earnings allows individuals to smooth their consumption over time.

Obstfeld (1985) uses this framework to analyze the response of savings and investment rates to permanent changes in population growth. The model is extended here to consider temporary and permanent shocks to technology. It will be shown that unanticipated disturbances to productivity lead to contemporaneous changes in savings and investment rates. As wages rise, the young generation increases its savings to smooth the "windfall" gain in income over its lifetime. Investment increases as the domestic return to capital temporarily exceeds the world interest rate. When the shock is anticipated, the rate of investment increases <u>prior</u> to the productivity shock. However, if some of the required installation of capital is not fully completed by the time of the increase in productivity, there will still be a correlation between savings and investment rates, though of a smaller magnitude.

Production and Investment:

Firms in the home country produce the consumption good using Cobb-Douglas technology,

$$(1) \qquad y_t = f(k_t, n_t) = \alpha_t k_t^{a} n_t^{1-a}$$

where k_t = capital stock at the beginning of period t

n_t = labor force, inelastically supplied, at t

a = capital share

α_t = value of a productivity parameter at t.

The population grows at rate g, so that at time t the size of the labor force is $n_0(1+g)^t$, where n_0 is normalized to one. Individuals are assumed to live for two periods. In the first period, individuals exchange their labor endowment for wages, w_t, and save out of this income for consumption when old. Individuals are assumed to have access to the international capital market, so that the return to their savings, whether held in the form of claims on domestic capital or as internationally traded bonds, must equal the exogenously determined world interest rate, ρ.

In equilibrium, the marginal products of capital and labor must equal the world interest rate and the domestic wage rate, respectively:

$$(2) \qquad \frac{\partial f(k_t, n_t)}{\partial k_t} = \rho$$

$$(3) \qquad \frac{\partial f(k_t, n_t)}{\partial n_t} = w_t$$

Capital requires one period for installation and it is assumed that there is no depreciation of the capital stock. The size of the labor force and the world interest rate determine the capital stock:

$$(4) \qquad k_t = \left[\frac{\rho}{\alpha_t a}\right]^{\frac{1}{a-1}} n_t$$

$$\frac{\partial k_t}{\partial \alpha_t} > 0, \quad \frac{\partial k_t}{\partial \rho} < 0, \quad \frac{\partial k_t}{\partial n_t} > 0.$$

Any change in the technology or the world interest rate alters the capital-labor ratio. Given the immobility of the labor force, all the adjustment to these disturbances must work through the capital stock.

From equations (1) through (4), it is possible to solve for the equilibrium levels of domestic wages and output as functions of the world interest rate, the labor supply and the productivity parameter.

$$(5) \qquad w_t = \alpha_t (1-a)\left[\frac{\rho}{\alpha_t a}\right]^{\frac{a}{a-1}}$$

$$\frac{\partial w_t}{\partial \alpha_t} > 0, \quad \frac{\partial w_t}{\partial \rho} < 0$$

$$(6) \qquad y_t = \alpha_t \left[\frac{\rho}{\alpha_t a}\right]^{\frac{a}{a-1}} n_t$$

$$\frac{\partial y_t}{\partial \alpha_t} > 0, \quad \frac{\partial y_t}{\partial \rho} < 0, \quad \frac{\partial y_t}{\partial n_t} > 0.$$

Wages and output both rise in response to an increase in productivity and fall as the world interest rate rises. The equilibrium wage rate is independent of n_t. For a given world interest rate, an increase in the number of workers is matched by an increase in the capital stock to maintain the optimal capital-labor ratio, leaving the wage rate unchanged. If the increase in the number of workers is unanticipated, there will be an intermediate stage where the capital-labor ratio is below its new steady-state optimum, and output and wages will rise until the new capital is fully installed.

Investment is defined as the change in the capital stock :

(7) $$i_t = k_{t+1} - k_t = \left[\frac{\rho}{\alpha_{t+1} a}\right]^{\frac{1}{a-1}} n_{t+1} - \left[\frac{\rho}{\alpha_t a}\right]^{\frac{1}{a-1}} n_t$$

$$= (1+g)^t \left\{\left[\frac{\rho}{\alpha_{t+1} a}\right]^{\frac{1}{a-1}} (1+g) - \left[\frac{\rho}{\alpha_t a}\right]^{\frac{1}{a-1}}\right\}.$$

Investment is a function of the world interest rate, current and future levels of productivity and the size of the labor force (or the rate of population growth).

To consider the steady-state level of investment, let $\alpha_t = \alpha_{t+1} = \alpha$. Investment then depends only on the world interest rate, the rate of population growth and the productivity parameter.

(8) $$i = g(1+g)^t \left[\frac{\rho}{\alpha a}\right]^{\frac{1}{a-1}}$$

Dividing by the steady-state level of output, the rate of investment is given by :

(9) $$\frac{i}{y} = \frac{a g}{\rho}$$

$$\frac{\partial(i/y)}{\partial g} > 0 \ , \ \frac{\partial(i/y)}{\partial a} > 0 \ , \ \frac{\partial(i/y)}{\partial \rho} < 0 \ .$$

An increase in the rate of population growth leads to an increase in the rate of investment as a direct result of the assumption of no labor mobility. As the labor force grows, the capital stock must continually increase to maintain a constant capital-labor ratio. Similarly, a higher level of steady-state productivity corresponds to a higher rate of investment.

Consumption and Savings

The consumer's problem is to maximize lifetime utility by choosing consumption for the two periods of his life subject to his wealth constraint. The problem for an individual who is "young" at t and "old" at t + 1 is:

$$\max \quad u(c_t) + \beta u(d_{t+1})$$

$$\text{s. t.} \quad c_t + \frac{d_{t+1}}{1+\rho} = w_t$$

where c_t = consumption when young

d_{t+1} = consumption when old

w_t = wages earned when young.

The first order condition for utility maximization shows the intertemporal trade-off between consumption in the two periods of the individual's life.

$$\frac{1}{(1+\rho)}\frac{\partial u}{\partial c_t} = \beta\frac{\partial u}{\partial d_{t+1}}$$

When $\beta = (1/1+\rho)$, individuals will choose a level of saving in the first period so as to smooth consumption: $c_t = d_{t+1} = c$. The equilibrium level of consumption is a function of the wage rate and the world interest rate.

$$(11) \qquad c = \left[\frac{1+\rho}{2+\rho}\right] w$$

In the steady-state (again assuming the interest rate and productivity level are each constant), the aggregrate level of savings in the economy, S^A, is defined as the positive savings of the young less the dissavings of the old:

$$(12) \qquad S_t^A = (1+g)^t (w-c) + (1+g)^{t-1}(\rho(w-c)-c)$$

$$= g\,\frac{(1+g)^{t-1}}{(2+\rho)}\,w.$$

The aggregate savings rate depends positively on the rate of population growth and negatively on the share of capital in national income and the world interest rate.

$$(13) \qquad \frac{S^A}{y} = \frac{g(1-a)}{(1+g)(2+\rho)}$$

$$\frac{\partial(S^A/y)}{\partial g} > 0, \quad \frac{\partial(S^A/y)}{\partial a} < 0, \quad \frac{\partial(S^A/y)}{\partial \rho} < 0.$$

Comparing equations (9) and (13), it is clear that permanent changes in the rate of population growth or the world rate of interest will lead to co-movements in savings and investment rates.

To evaluate short-run or out-of-steady-state changes in savings, consider the savings of the young generation at t:

$$(14) \qquad s_t = w_t(\alpha_t, P) - c_t(B, P, w_t(\alpha_t, P))$$

The amount of savings of the young unambiguously rise in response to an increase in productivity. The net effect of a rise in the interest rate, however, depends on the relative magnitude of the income and substitution effects as shown in (16).

$$(15) \qquad \frac{\partial s_t}{\partial \alpha_t} = \frac{\partial w_t}{\partial \alpha_t}\left(1 - \frac{\partial c_t}{\partial w_t}\right) > 0$$

$$(16) \qquad \frac{\partial s_t}{\partial \rho} = \frac{\partial w_t}{\partial \rho}\left(1 - \frac{\partial c_t}{\partial w_t}\right) - \frac{\partial c_t}{\partial \rho}$$

Assuming zero population growth, an alternative definition of aggregate savings is the change in the savings of the young generation at t and the young generation at t - 1,

$$(17) \qquad S_t^A = \hat{s}_t - \hat{s}_{t-1}$$

where $\hat{s}_t = w_t - c_t$ and $\hat{s}_{t-1} = \rho(w_{t-1} - c_{t-1}) - d_{t-1}$. Equations (9) and (13) determine the long-run or steady-state savings and investment levels, while equations (7), (14) and (17) reveal short-run or out-of-steady-state responses to exogenous disturbances. Finally, using equations (7) and (12), it is possible to define the current account as the difference between aggregate savings and domestic investment.

$$(18) \qquad CA_t = S_t^A - i_t$$

Productivity shocks:

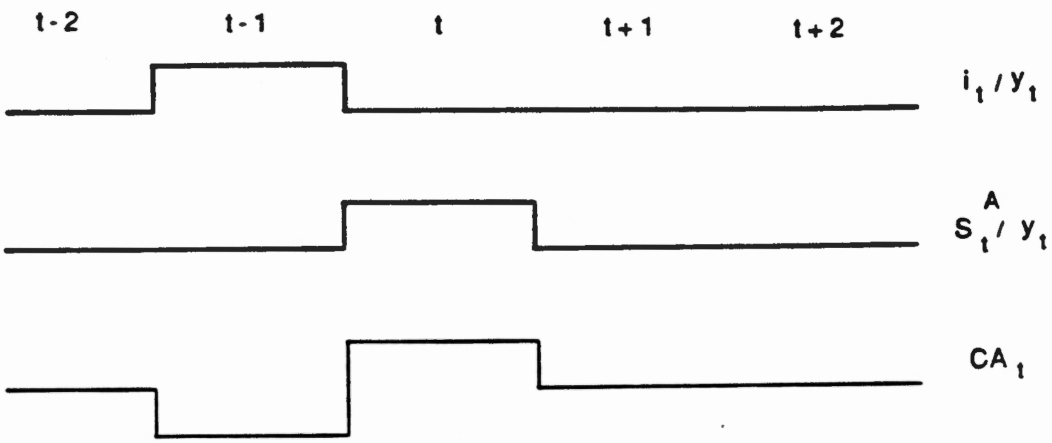
The overlapping generations framework is easily solved for the period-by-period adjustments following an exogenous disturbance. In particular, it is possible to evaluate the responses to temporary and permanent, anticipated and unanticipated, disturbances. It will be shown that, under the assumptions of this particular model, unanticipated shifts in productivity lead to contemporaneous adjustments in savings and investment.

i) Consider a permanent, anticipated increase in α at date t. As shown in Figure 1, output and wages rise in period t; the increase in wages causes the level of savings of the young generation to increase by $(\partial w / \partial \alpha)$ times the marginal propensity to save. There is a one period increase in aggregate savings; consumption, or dissaving, of the old generation at t is determined by the level of wages at time t - 1, and is thus unchanged, while savings of the young at t rises commensurately with the increase in wages. The savings rate returns to the steady-state rate at t + 1 as both the young and old generations increase their levels of consumption in accordance with the higher level of output. Investment rises at t - 1 in anticipation of the increase in productivity so that the new capital stock will be installed and ready for production at the time of the increase in α. Thus, the rise in investment precedes the increase in savings by one period resulting in a "cyclical" pattern in the current account.

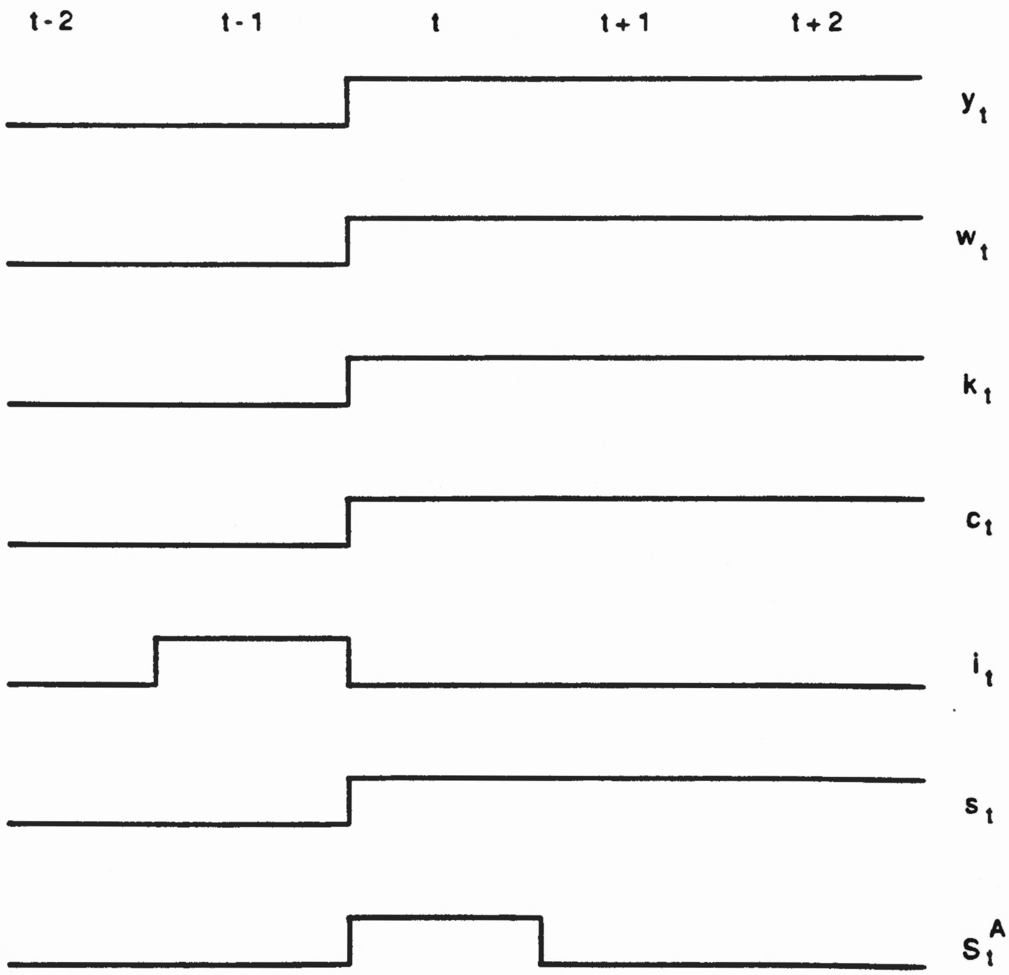
(Figure 1)

Figure 1: **<u>Permanent, Anticipated Increase in Productivity at t</u>**

Investment, Savings and the Current Account as shares of GDP



Changes in other aggregate variables



ii) Suppose the permanent increase in α is unanticipated at all dates prior to t. In this case, pictured in Figure 2, output and wages increase in two stages. First, output and wages rise in reponse to the higher level of productivity at time t. Investment increases at the time of the shock so that the newly installed capital is ready for production at time t + 1. Output and wages then rise again at t + 1 due to the higher level of productivity and because there is more capital in production. Saving of the young exceeds the dissaving of the old at t and t + 1 so that aggregate savings is positive in both periods. (Whether S^A increases or decreases between t and t + 1 depends on the relative magnitudes of the elasticities of wages with respect to the increase in productivity and the increase in capital. Figure 2 is drawn under the assumption that the changes in α and the capital stock have the same effect on wages so that S^A is at the same level at t and t + 1.) Thus, investment and savings both rise at the time of the productivity shock, with some persistence in the response of savings. The balance on current account may be positive or negative at t, depending on whether the increase in productivity has a stronger initial impact on savings or investment. At t + 1, the balance on current account is unambiguously positive as savings rises again with the additional increase in wages.

(Figure 2)

iii) Now suppose there is an anticipated productivity shock which lasts only for periods t, t+1 and t + 2 (see Figure 3). Output and wages are higher during the period of high productivity and return to the steady-state in t + 3. Consumption and saving of the young generation rises in this interval; aggregate savings is positive in t, and returns to zero during t + 1 and t + 2 as consumption of the old rises to the same level as consumption of the young. In t + 3, the dissavings of the old, which were based on the wage rate in the previous period, exceed the savings of the young, resulting in a negative aggregate savings rate. The beginning and the end of the productivity shock are anticipated, so the capital shock moves with the change in α. Investment rises prior to the shock and falls during the last period of the shock when k_t returns to its steady-state level. As in the case of a permanent anticipated productivity shock, changes in the investment rate precede changes in the aggregate savings rate and a cyclical pattern appears in the current account both at the beginning and end of the period of high productivity. Since the end of the shock is assumed by convention to be fully anticipated, the "ends" of the shocks will have the characteristics of anticipated disturbances.

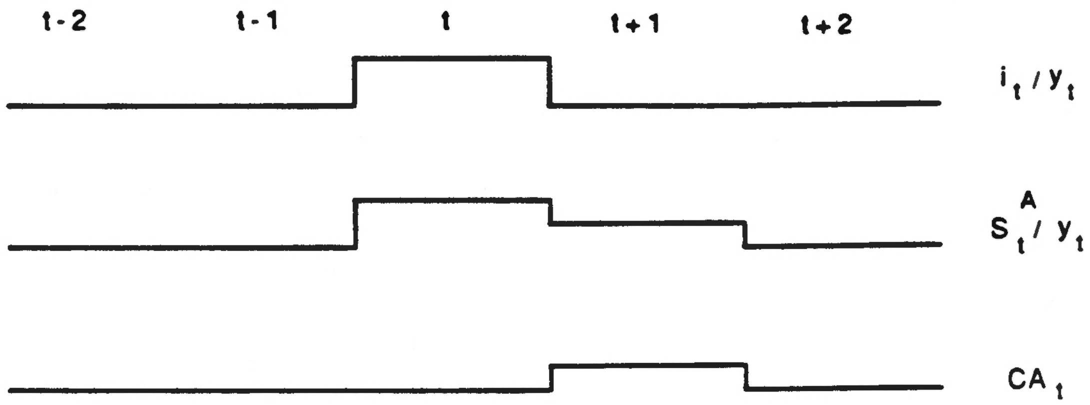
(Figure 3)

iv) Finally, consider a temporary, unanticipated increase in productivity (Figure 4). Analogously to case ii), output and wages increase in two stages as a result of the lag in adjustment of the capital stock. Aggregate savings thus rises contemporaneously with investment. Investors foresee the end of the productivity shock so, as in i), the fall in investment precedes the fall in savings at t + 2.

(Figure 4)

Figure 2: <u>Permanent, Unanticipated Increase in Productivity at t</u>

Investment, Savings and the Current Account as shares of GDP



Changes in other aggregate variables

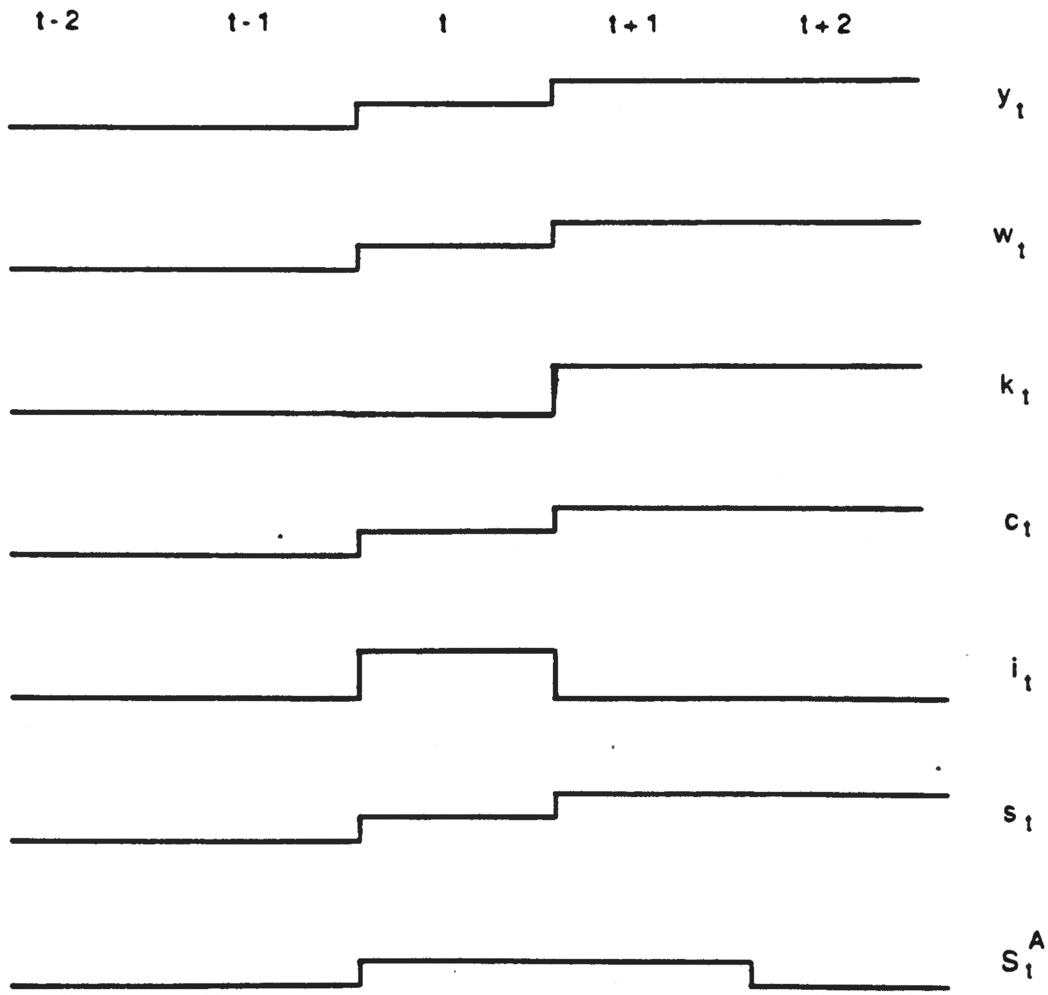
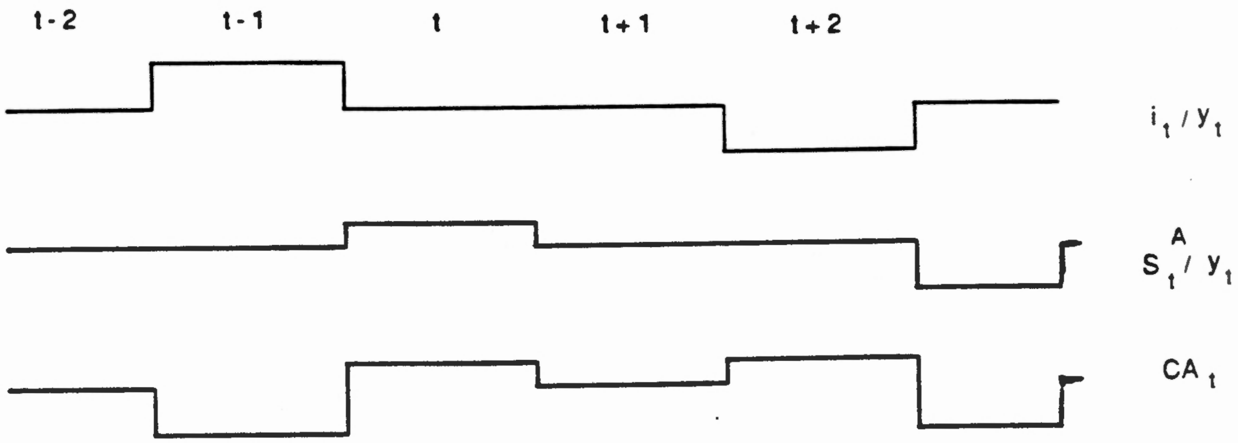


Figure 3: <u>Temporary, Anticipated Increase in Productivity at t, t+1, and t+2</u>

Investment, Savings and the Current Account as shares of GDP



Changes in other aggregate variables

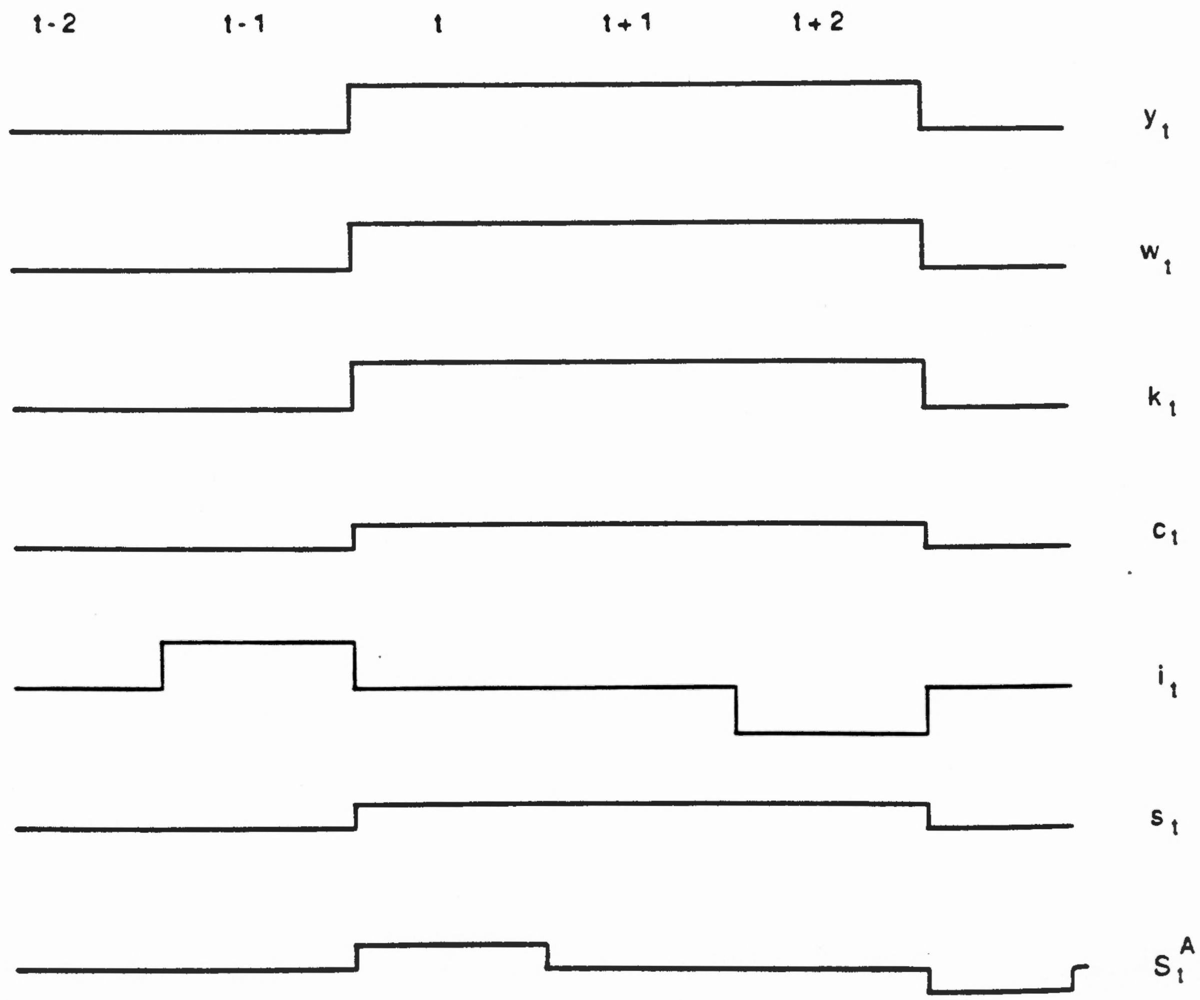
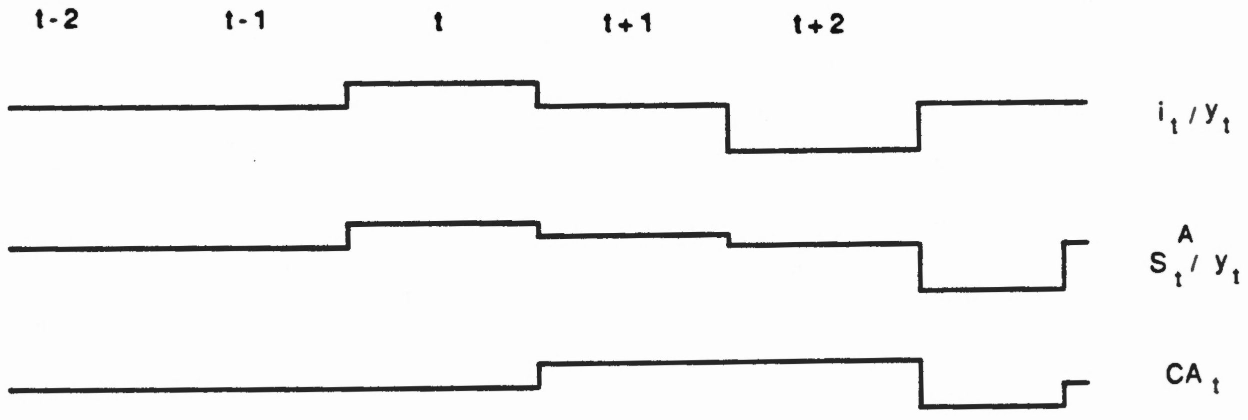
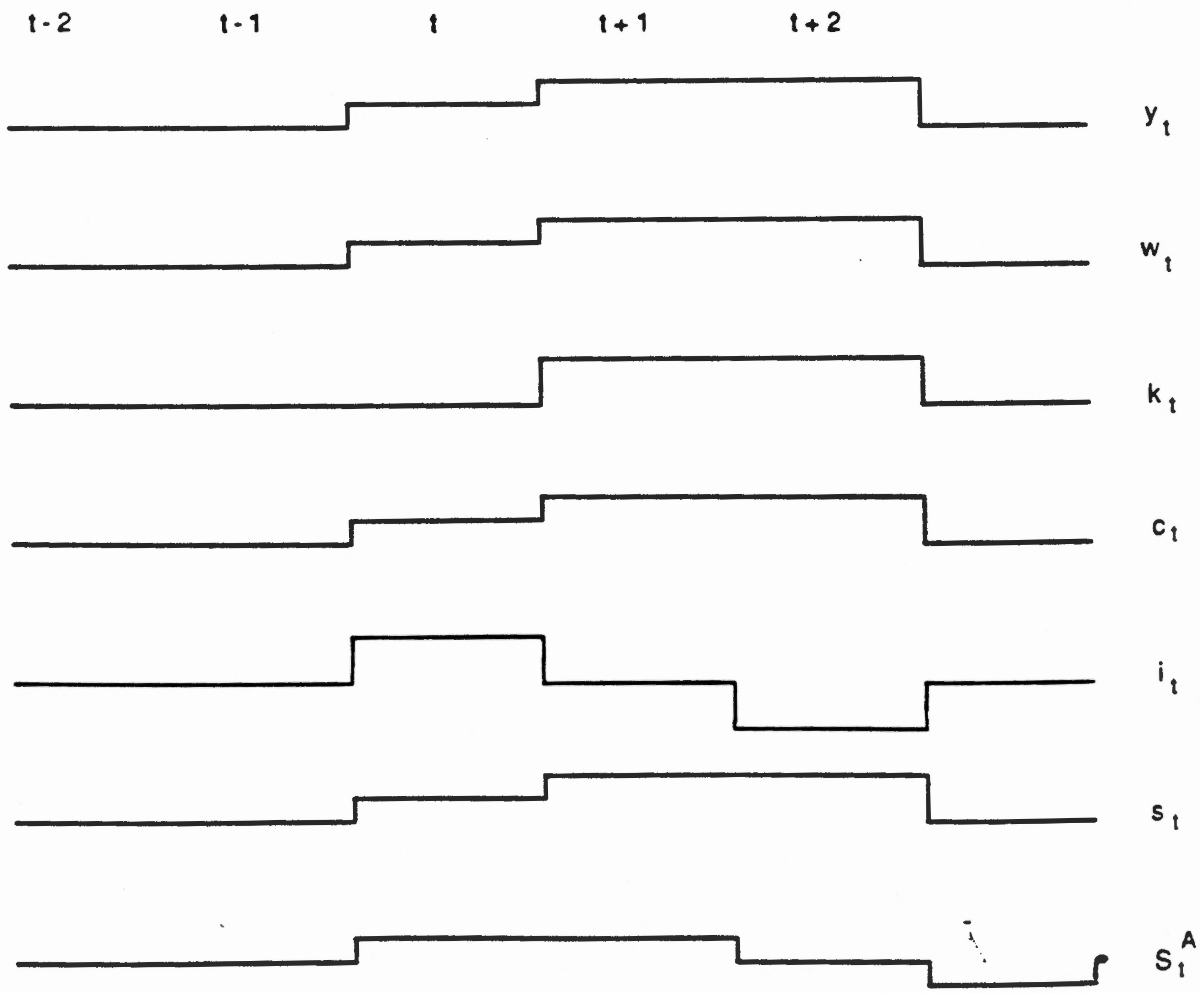


Figure 4: <u>Temporary, Unanticipated Increase in Productivity at t, t+1, and t+2</u>

Investment, Savings and the Current Account as shares of GDP



Changes in other aggregate variables



These examples of changes in productivity highlight the interaction between changes in the capital stock and savings behavior. In this type of model, the timing of the shock is crucial: given the one-period installation requirement for capital and the individual's uneven pattern of earnings over his lifetime, exogenous disturbances lead to large swings in savings and investment rates. In the case of an anticipated shock, investment adjusts prior to the increase in productivity so that wages, output, consumption and savings all increase at the time of the disturbance. If the shock is unanticipated, the increase in the capital stock occurs with a lag and the changes in output, wages and consumption will be less sharp. In this case, the lag in investment leads to the correlation between savings and investment rates.

A shortcoming of the overlapping generations framework is that the planning horizon of savers (presumably, a generation lasts about thirty years) does not match up well with the decision problem facing investors. Despite this obvious problem, the model yields some interesting, and I believe, plausible predictions. As long as some component of the disturbances to productivity is unexpected, changes in investment will occur simultaneously with the changes in wages and income. Any change in wages will then lead to a reallocation between savings and consumption. The time frame of the investment problem and the consumption/savings choice can be made more realistic along the lines suggested by Blanchard (1985). However, even in this basic setup, the model suggests that co-movements in savings and investment rates are a predictable response to changes in productivity.

Despite the fact that all individuals in this economy have access to international financial markets for borrowing and lending, it should be noted that these markets are not completely unrestricted in the sense that workers are not permitted to trade contingent claims on their labor income. If the exogenous shocks to productivity are less than perfectly correlated across countries, workers will have an incentive to insure themselves against adverse changes in their wages. This restriction on capital markets is probably not unrealistic but it is important as trade in such claims would break the link between savings and investment.

Thus far, only supply-side shocks (productivity and population growth) have been shown to produce a positive correlation between savings and investment rates. The model can be used to analyze demand shocks, but only the savings rate will be affected as long as the rate of investment is linked to the world interest rate. In the following model, the inclusion of a nontraded capital good introduces a domestic rate of return to capital different from the world rate that is sensitive to demand as well as supply shocks.

IV. Savings and Investment with a Nontraded Capital Good

In the previous model, the correlation between savings and investment depended on the timing of the shock to productivity and the life-cycle pattern of consumption and savings. Now, by relaxing the assumptions about consumption and savings and by adding a nontraded good, the correlation between savings and investment arises not merely as an artifact of timing but due to restrictions on trade in the goods market. While this assumption about the exchange of the nontraded good effectively restricts capital flows, an interesting result of this model is that perfect co-movements between savings and investment are not guaranteed. It will be shown that the magnitude of the correlation between savings and investment depends critically on the representative individual's preferences for the two goods. The effects of demand and supply shocks are first analyzed in a two-period framework. The model is then extended to the infinite-horizon and the effects of uncertainty are considered.

Two-period Model

In this economy, there are two goods available for consumption: the traded good, y_t, which arrives at the beginning of the period as an endowment, and x_t, which is produced using the nontraded capital good. Output of x is given by

$$(1) \qquad x_t = \alpha_t f(k_t)$$

where α_t is a productivity parameter and by assumption, $f'(k) > 0$, and $f''(k) < 0$.

Current output of the nontraded good can be invested for use in future production of x or for current consumption, x_t^d. The resource constraint in each period is then

$$(2) \qquad \alpha_t f(k_t) - x_t^d - i_t \geq 0.$$

I will assume that the intial capital stock, k_1, is given and capital depreciates completely between periods. The resource constraints for periods one and two are

$$(3a) \qquad \alpha_1 f(k_1) - x_1^d - k_2 \geq 0$$

$$(3b) \qquad \alpha_2 f(k_2) - x_2^d \geq 0$$

and the terminal condition, $k_3 = i_2 = 0$, is imposed on the last period's capital stock.

Consumers trade the endowment good, y_t, with the rest of the world to smooth consumption over time. The intertemporal balance of payments condition requires that the present value of lifetime consumption of y be less than the present value of the endowment stream of y,

$$(4) \qquad y_1 + \left[\frac{1}{1+\rho}\right] y_2 \geq y_1^d + \left[\frac{1}{1+\rho}\right] y_2^d$$

where ρ is again the exogenously given world interest rate and y_t^d denotes consumption of the traded good in period t.

The representative consumer's problem is to maximize lifetime utility over consumption of x and y subject to the resource constraints on the nontraded good, (3a) and (3b), and the balance of payments constraint (4),

$$\max U(x_1^d, y_1^d) + \beta U(x_2^d, y_2^d)$$

where $U_1(\cdot)$ denotes the derivative with respect to the first argument and the standard assumptions are made about the concavity of the utility function: $U_1 > 0$, $U_2 > 0$, $U_{11} < 0$, $U_{22} < 0$. Solving for the first-order conditions in the two goods yields:

$$(5) \qquad \beta U_1(x_2^d, y_2^d)\, \alpha_2 f'(k_2) = U_1(x_1^d, y_1^d)$$

$$(6) \qquad \beta U_2(x_2^d, y_2^d) = \left[\frac{1}{1+\rho}\right] U_2(x_1^d, y_1^d).$$

Equation (5) states that the marginal cost of reducing consumption in period one must equal the marginal benefit of having more capital in production next period, and therefore more consumption. Equation (6) implies that the intertemporal marginal rate of substitution of the traded good must equal the the world interest rate.

Individuals in this economy can save for future consumption either by investing in the production of the nontraded good or by lending to the foreign country by trading contingent claims in the international capital market. The definition of national savings is the difference between output and consumption of both the traded and nontraded goods:

$$(7) \qquad s_1 = p_1(x_1 - x_1^d) + (y_1 - y_1^d)$$

$$\text{where } p_1 = \frac{U_1(x_1^d, y_1^d)}{U_2(x_1^d, y_1^d)},$$

the relative price of the nontraded good. From the resource constraints on the nontraded good it is clear that the amount of national savings is directly linked to the amount of domestic investment in the nontraded sector:

$$(7a) \qquad s_1 = p_1 k_2 + (y_1 - y_1^d).$$

The larger the share of nontraded goods in total output, the more closely savings and investment rates will be correlated.

Using the first-order condition for capital and (7a) it is possible to determine the effects of a change in second-period productivity on savings and investment. Totally differentiating equation (5) reveals that investment increases (decreases) when the coefficient of relative risk aversion (γ), or the intertemporal elasticity of marginal utility of the nontraded good, is less than (greater than) one:

$$(8) \qquad \frac{\partial k_2}{\partial \alpha_2} \gtrless 0 \quad \text{iff} \quad -\frac{U_{11}(x_2^d, y_2^d)}{U_1(x_2^d, y_2^d)} x_2^d = \gamma \lessgtr 1.$$

An increase in productivity has two effects on the capital stock. First, the marginal product of capital rises in the second period, increasing demand for investment and reducing consumption of the nontraded good in period one. Second, for a given level of k_2, the higher level of productivity increases total income which leads to greater demand for consumption in both periods. When $\gamma < 1$, there is sufficient intertemporal elasticity of substitution in the nontraded good for the substitution effect on investment to dominate the income effect.

The response of savings to a future productivity shock is complicated by the change in the relative price of the nontraded good. From the definition of national savings:

$$(9) \qquad \frac{\partial s_1}{\partial \alpha_2} = \left\{ k_2 \left[\frac{U_1(x_1^d, y_1^d)\, U_{21}(x_1^d, y_1^d)}{[U_2(x_1^d, y_1^d)]^2} - \frac{U_{11}(x_1^d, y_1^d)}{U_2(x_1^d, y_1^d)} \right] + \frac{U_1(x_1^d, y_1^d)}{U_2(x_1^d, y_1^d)} \right\} \frac{\partial k_2}{\partial \alpha_2}.$$

The effect of increased second-period productivity on national savings can be broken down into two parts. The term inside the square brackets reflects the change in the relative price of the nontraded good as a result of the increased demand for that good in investment. The remaining term reflects the direct investment response to higher second period productivity at unchanged prices.

The magnitude of the savings response depends critically on the change in the relative price as investment of the nontraded good changes. This in turn depends on the elasticity of substitution in consumption between the traded and nontraded goods. Consider again the case when $\gamma < 1$. Intuitively, as productivity in the second period rises, demand for investment in the nontraded goods sector rises and the relative price of the nontraded good increases. Consumption of the nontraded good then falls and savings rises, thus bringing about the correlation between savings and investment. If the demand for the nontraded good is inelastic, the price of the nontraded good must rise by a large amount to induce consumers to sacrifice consumption of the nontraded good for investment. Conversely, if consumers readily substitute toward the traded good, a small change in the relative price is sufficient to reduce consumption of the nontraded good and the overall effect on savings will be small.[7] It can be shown that with a constant elasticity of substitution specification for preferences, the magnitude of the savings response to a given shift in investment is decreasing in the elasticity of substitution between the two goods.[8]

Demand shocks:

In this model, it is possible to consider the effects of exogenous changes in demand as well as supply. The utility function can be rewritten to include multiplicative demand shocks on consumption of the traded and nontraded goods. The representative consumer now maximizes

$$U(e_1 x_1^d, v_1 y_1^d) + \beta U(e_2 x_2^d, v_2 y_2^d)$$

subject to (3a), (3b) and (4), where $\{e_t, v_t\}$ represent exogenous shifts in the demand for the nontraded and traded goods, respectively. Analogously to equations (5) and (6), the first-order conditions for the two goods are:

$$(10) \qquad e_2 \alpha_2 f'(k_2) \beta U_1(2) = e_1 U_1(1)$$

$$(11) \qquad v_2 U_2(2) = \left[\frac{1}{1+\rho}\right] v_1 U_2(1).$$

The notation is abbreviated so that $U_1(t)$ is the derivative with respect to x in period t. The "demand shocks" on the two goods affect both the marginal rates of substitution between goods and over time. Again by totally differentiating equation (10), it is clear that the investment response to a first-period demand shock again depends on the coefficient of relative risk aversion.

$$(12) \qquad \frac{\partial k_2}{\partial e_1} \lesseqgtr 0 \quad \text{iff} \quad -\frac{U_{11}(1)}{U_1(1)} e_1 x_1^d = \gamma \lesseqgtr 1.$$

Similarly, the magnitude of the savings response depends on the change in relative prices:

$$(13) \qquad \frac{\partial s_1}{\partial e_1} = \left\{ -e_1 k_2 \frac{U_{11}(1)}{U_2(1)} + e_1 k_2 \frac{U_1(1)\, U_{21}(1)}{[U_2(1)]^2} + \frac{U_1(1)}{U_2(1)} \right\} \frac{\partial k_2}{\partial e_1} + \left\{ \frac{U_2(1)\, U_{11}(1) - U_1(1)\, U_{21}(1)}{[U_2(1)]^2} \right\} x_1^d k_2.$$

The intuition for these results is the same as in the case of a productivity shock. The greater the responsiveness of demand to a change in prices the smaller the savings response to a given change in investment. Conversely, the more inelastic the demand response, the larger the correlation between savings and investment rates resulting from both demand and productivity shocks. Loosely speaking, when consumers are less willing to substitute the traded good for the nontraded good as relative prices change, the levelof savings becomes more tightly linked to the level of investment. Repeating the analysis for a second-period demand shock reveals that both first-period savings and investment rise when the coefficient of relative risk aversion is less than one.

Infinite-horizon Model

The two-period problem is quite easily extended to the infinite-horizon with uncertainty. Again, the economy produces a nontraded good for consumption which requires a nontraded capital good in production. Output of the nontraded good depends on the level of the domestic capital stock and the productivity parameter, α_t, an exogenous random variable:

$$x_t = \alpha_t f(k_t) = X_t(\alpha_t, k_t). \tag{14}$$

The capital good used in production must be taken out of the previous period's production of the nontraded good. Assuming complete depreciation of the capital stock between periods, the resource constraint

$$\alpha_t f(k_t) - k_{t+1} - x_t^d \geq 0 \tag{15}$$

must be satisfied for any period t.

The home country receives the consumption good y as an endowment at the beginning of each period which can be traded in the international goods market. The representative individual has rational expectations over θ_t, the random exogenous process which determines the sequence of endowments of the tradable consumption good, and over α_t. Based on these expectations, the individual trades in a contingent claims market to smooth consumption over time given the lifetime budget constraint:

$$y_0 + \sum_{t=1}^{\infty} \left[\frac{1}{1+\rho}\right]^t y_t \geq y_0^d + \sum_{t=1}^{\infty} \left[\frac{1}{1+\rho}\right]^t y_t^d \tag{16}$$

where the interest rate is assumed to be constant. Given rational expectations and a time-zero contingent claims market, the exchange of one-period bonds is sufficient for consumption-smoothing. The budget constraint for each period t is:

$$y_t + b_t(1+\rho) \geq y_t^d + b_{t+1} \tag{17}$$

where b_t is the price of a one-period bond which matures at time t. Note that without any further restrictions on preferences, these bonds may be contingent on the output of the nontraded good as well as the traded good.

The representative consumer maximizes the present-value of expected lifetime utility

$$\max \quad E_t \sum_{\tau=t}^{\infty} \beta^{\tau-t} U(x_\tau^d, y_\tau^d)$$

subject to the resource constraints on the nontraded good and the trade budget constraints. In addition, the following initial and solvency conditions are imposed on capital and debt:

$$(18a) \qquad \dot{k} \geq k_0$$

$$(18b) \qquad \dot{b} \geq b_0$$

$$(19a) \qquad \lim_{t \to \infty} \left[\frac{1}{1+\rho}\right]^t k_t = 0$$

$$(19b) \qquad \lim_{t \to \infty} \left[\frac{1}{1+\rho}\right]^t b_t = 0.$$

The solution to the optimization problem defines the value function

$$v(k,b;s) = \max U(x^d, y^d) + \beta \int v(k', b'; s') \, dF(s, s').$$

The nonprimed variables refer to period t, the primed variables to period t + 1. The state vector s is defined as $s = (\alpha, \theta)$ and $F(s, s')$ is the distribution function of a first-order Markov process over both of the state variables.

The necessary conditions for utility maximization are listed in equations (20a) - (20d) where μ is the Lagrange multiplier on the resource constraint for the nontraded good and λ is the multiplier on the trade budget constraint.

$$(20a) \qquad \mu = U_1(x^d, y^d)$$

$$(20b) \qquad \lambda = U_2(x^d, y^d)$$

$$(20c) \qquad \mu = \beta \int \mu' \alpha' f'(k') \, dF(s, s')$$

$$(20d) \qquad \lambda = \beta \int \lambda' (1+\rho) \, dF(s, s')$$

Combining these equations yields the first-order conditions determining the optimal levels of investment and borrowing in the bond market.

$$(21) \qquad U_1(x^d, y^d) = \beta \int U_1(x^{d'}, y^{d'}) \, \alpha' f'(k') \, dF(s, s')$$

$$(22) \qquad \left[\frac{1}{1+\rho}\right] = \frac{\beta \int U_2(x^{d'}, y^{d'}) \, dF(s, s')}{U_2(x^d, y^d)}$$

Equilibrium

An equilibrium in this economy is the set of functions λ, μ, x^d, y^d, b', and k' which are functions of the state variables (k , s). These functions satisfy the constraints (15) , (17) , the necessary conditions for utility maximization and the following market-clearing conditions.

$$y_t^d + y_t^{d*} = y_t + y_t^* \tag{23a}$$

$$b_t + b_t^* = 0 \tag{23b}$$

The starred variables are output, consumption and bondholdings of the rest of the world. Equation (23a) requires that world consumption equals world output and (23b) that the supply of bonds equals the demand for bonds.

Investment and Savings

The level of investment in this economy is the function K' (k, s) implicitly determined by equation (21). Savings is again defined as the difference between output of the traded and nontraded goods less the level of consumption of both goods.

$$s(k,s) = p(k,s)\, K'(k,s) + y(k,s) - y^d(k,s) \tag{24}$$

The response of savings and investment to future productivity shocks and demand shocks is analogous to the two-period model. An increase in future productivity, α', leads to an increase in both savings and investment as long as

$$\gamma = -\frac{\int U'_{11}(x^{d'}, y^{d'})\, \alpha' f'(k')\, dF(s,s')}{\int U'_1(x^{d'}, y^{d'})\, dF(s,s')} < 1 \tag{25}$$

Again, the magnitude of the savings response depends on the elasticity of substitution between the traded and nontraded goods. Similarly, exogenous changes in current and future demand can lead to co-movements in savings and investment.

The incorporation of a nontraded capital good under uncertainty thus generates a positive correlation between savings and investment in response to both supply and demand shocks. Expected future increases in demand for the nontraded good raises the expected marginal product of capital in the nontraded sector, causing investment to rise. The supply of nontraded goods available for consumption shrinks and consumers are forced to save or to substitute toward the traded good. Similarly, expected increases in productivity in the nontraded sector raises the return to investment and crowds out consumption. If these underlying shocks to demand or productivity are serially correlated the correlation between savings and investment will persist over time.

In contrast with the overlapping generations framework, this model produces the correlation in response to virtually any shock to the nontraded sector, independently of the timing or the duration of the shock. This result may seem trivial since it was achieved by simply shutting down trade, effectively "closing" the economy off from the rest of the world. However, it should be emphasized that trade in the goods market is restricted, but again, no constraints are placed on asset trade. When utility is separable in the traded and nontraded goods there will in fact be no trade in claims to the nontraded good; individuals are unwilling to substitute the traded good for the nontraded good so only the consumption of the traded good is smoothed. As the elasticity of substitution between the traded and nontraded goods increases, consumers begin to trade in assets which pay dividends in the traded good contingent on the realization of output of the nontraded good. To the extent individuals are willing to accept the traded good when the nontraded good is in short supply, the link between savings and investment is weakened.[9]

The addition of labor to the model would reduce the magnitude of the correlation between savings and investment. In the absence of labor in production, firms are able to adjust to exogenous distubances only by adjusting the capital stock, which directly affects consumption and savings. When labor is used as a factor of production, firms have another channel for substitution in production. A testable implication of these models is that labor will bear a larger burden of the adjustment in countries where the nontraded goods sector is a significant share of total output than in those countries that can rely on international capital flows to help respond to exogenous shocks. If labor is relatively mobile within the domestic economy, these adjustments will be reflected in movements of the labor force between the sectors. If labor is not mobile between sectors, countries with large nontraded goods sectors will be characterized by greater wage differentials across sectors.

The restriction on trade of investment goods appears to be a rather special type of assumption. The label "nontraded capital good" could be applied to any good that is required in production and is not readily substitutable for some other good exchanged in international markets. To list just a few, goods that are specific to domestic firms or industries, management and banking services, and employees with high levels of firm-specific human capital are examples of "investment goods" that are developed by firms for domestic production. Whether these types of nontraded goods are sufficiently important to restrict aggregate measures of savings and investment remains to be tested. Consumer durables and firm expenditures on production facilities and large-scale (non-transportable) machinery are two possible measures of the importance of nontraded investment goods.

V. Conclusion

The objective of this paper is to review the existing evidence on the correlation between savings and investment rates in the OECD countries and to evaluate its relevance to the question of international capital mobility. The statistics presented in this paper suggest that the correlation between savings and investment is both a short- and very long-run phenomenon and is not restricted to a particular sample of countries. This empirical evidence poses a difficult challenge for theoretical models; explanations based on exogenous changes in the rate of population growth in a model with imperfect labor mobility may explain some of the long-run co-movements between savings and investment but cannot address the short-run movements. On the other hand, models incorporating temporary demand and productivity shocks produce short-run co-movements but have the disadvantage that the shocks must occur with sufficient frequency to produce long-run correlations within countries over time as well as across countries.

In a world with complete international financial markets, free trade, and unrestricted factor mobility, the level of domestic investment is independent of the supply of national savings. The strategy adopted in this paper is to explain the observed linkage between savings and investment rates by building frictions into the economy without severely restricting international financial markets. An important feature of both of the models developed in this paper is the assumption that labor is immobile and is inelastically supplied. Introducing a problem of labor choice between work and leisure, between industries, or by allowing the migration of labor across national borders, reduces the magnitude of the investment response to exogenous disturbances. In effect, labor mobility opens another channel for substitution in production; as productivity changes, workers migrate to the country (or industry) with the highest wages, reducing the need for firms to adjust their capital stock. Thus, the restriction on labor mobility is sufficient to produce a weak correlation between savings and investment, independent of the assumptions made about the international capital market.

In conjunction with the assumption about labor mobility, international financial markets are also restricted in the sense that workers in different countries are not allowed to trade contingent claims on their labor income. While I do not believe that this is an unrealistic assumption, it should be noted that trade in such claims would significantly reduce the savings response to exogenous disturbances.

The life-cycle pattern of consumption and savings behavior described by the overlapping generations model restricts the economy's ability to smooth shocks to productivity and wealth. Since individuals only work for one period, any change in wages, temporary or permanent, will lead to a reallocation between savings and consumption. On the investment side, the imposition of an installation requirement on capital reduces the ability of investors to respond quickly to changes in productivity. The assumptions of the second model impose even tighter constraints on savings and investment behavior by restricting the exchange of a good used for consumption and investment.

Virtually any disturbance to the sector isolated from international markets leads to co-movements in the domestic investment and national savings rates.

It seems clear that constraints on labor mobility, consumption-smoothing and the exchange of goods provide explanations for the savings and investment correlation independently of the role of financial markets. The remaining task for future research is to evaluate whether any of these restrictions, or some combination of restrictions, is sufficiently important empirically to explain the observed savings and investment behavior of the OECD countries.

Footnotes

1. The appropriate variables are national savings and domestic investment.

2. The sample studied by Feldstein and Horioka includes Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Sweden, the United Kingdom and the United States. France, Luxembourg, Norway, Spain and Switzerland were dropped from the sample as the authors assert that these countries significantly changed their methods of national income accounting during the period of study.

3. Sachs' conclusion that I/GDP is a better explanatory variable for movements in the current account is based on the following regression for "all countries" (15 OECD countries, Brazil, Colombia, Korea, Mexico, and Thailand):

$$\Delta(CA/GNP) = -.61\ \Delta(I/GNP) \qquad R^2 = .72 \quad \text{t-stat}=-6.2$$

$$\Delta(CA/GNP) = -.34\ \Delta(S/GNP) \qquad R^2 = .00 \quad \text{t-stat}=-1.0$$

These figures are reported in Table 14, p.250, Sachs (1981). The change measures the difference in averages over the intervals 1968-73 and 1974-79. Similarly in Sachs (1983), Table 2:

$$\Delta(CA/GNP) = -.01 - .65\,\Delta\,(I/GNP) \qquad R^2 = .65 \quad \text{t-stat}=4.2 \quad \text{(excluding Japan)}$$

$$\Delta(CA/GNP) = -.01 - .15\Delta\ (I/GNP) \qquad R^2 = .01 \quad \text{t-stat}=1.1 \quad \text{(excluding France)}$$

This sample includes the 14 OECD countries listed in Table 1. The data are averaged over the periods 1961-70 and 1971-79.

4. The countries reporting non-zero values for the statistical discrepancy include Australia, Canada, Finland, United Kingdom, Iceland, Japan, New Zealand, Netherlands, Portugal, Sweden and the United States.

5. The rate of growth in GDP is another possible spurious variable in the savings-investment correlation; countries with rising incomes are likely to exhibit both higher rates of saving and investment over time. Fry (1986) attributes the savings-investment correlation in a cross-section of Asian counries to differing rates of growth. While this is probably a contributing factor to co-movements in savings and investment in the OECD countries, it has not been shown to fully account for the correlation.

6. The strong linkage between savings and investment rates over time is not a characteristic of all OECD countries. Norway, for example, ran a persistent current account deficit during its investment boom in the 1970s.

7. When $\gamma > 1$, the explanation is reversed. The price of the nontraded good falls as investment decreases to induce people to consume more of the nontraded good. The more inelastic the demand response, the more the price must fall leading to a larger savings response.

8. Note that when $U_{12}(\ )$ is large and negative, the price will fall as investment increases and savings may decrease. I conjecture that this case is ruled out by the second-order conditions on utility maximization and stability but I have been unable to prove this for a general specification of preferences and production. When utility is separable, when the traded and nontraded goods are perfect substitutes and for all CES utlity functions, the price effect is never large enough to cause savings and investment to be negatively correlated.

9. This result is not directly apparent from the model but can be seen indirectly by considering equation (6). Individuals equate the marginal utility of the traded good over time to the world rate of interest where the marginal utility depends on the consumption of both the traded and nontraded goods. Thus, the consumption pattern of the traded good must not only smooth the consumption of that good, but also must take into account the stochastic variations in the nontraded good to smooth overall utility. To see this more clearly, one can totally differentiate (6) to evaluate the response of consumption to exogenous shocks. The presence of cross-derivatives indicates that the elasticity of substitution between the two goods will play a role in determining the consumption pattern of the traded good that will smooth overall utility.

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