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THE SOCIALLY OPTIMAL LEVEL OF SAVING IN AUSTRALIA, 1960-61 TO 1994-95

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SEMINAR PAPER NO. 10/97

For Limited Distribution Only

DEPARTMENT OF ECONOMICS

SEMINAR PAPERS

15.6.97
File: Optsav3.1

ABSTRACT

The Socially Optimal Level of Saving in Australia, 1960-61 to 1994-95

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In this paper a model is developed which determines the socially optimal level of saving for a small open economy. The model also determines the socially optimal disposition of saving between domestic capital accumulation and overseas asset accumulation. The model is then applied to the Australian economy for the period 1960-61 to 1994-95. For each year of that period socially optimal levels of saving, investment and the current account of the balance of payments are determined. Two main conclusions emerge. Firstly, while Australia under-saved by an average of 1.7% of GDP from 1974/75 to 1994/95, it over-saved by an average of 5.3% of GDP in the earlier period from 1960-61 to 1973-74. Secondly, Australia did not make optimal use of world capital markets to smooth consumption in the period from 1960-61 to 1994-95, although there is less evidence for this since 1984-85, suggesting that deregulation of capital markets may have facilitated the optimal smoothing of consumption.

I Introduction

The emergence in Australia in the 1980's of large current account deficits in the order of four to five percent of GDP and the persistence of these large deficits has led to many expressions of concern that Australia is borrowing too much from overseas. The counter-argument put forward by Pitchford (1990) does not appear to have laid these concerns to rest. Furthermore, the low level of saving in Australia in the 1980's and 1990's relative to the 1960's has added to these concerns a fear that Australia is saving too little. The previous government commissioned the FitzGerald Report, FitzGerald (1993), to investigate the saving problem. FitzGerald recommended that saving should be raised by five percentage points of GDP.[1]

The aim of this paper is to apply a model based on the intertemporal approach to the current account in order to evaluate Australia's record of saving, investment and overseas borrowing for the period 1960-61 to 1994-95. The application of the model yields series for the optimal levels of national saving, investment and the current account deficit for Australia for the period 1960-61 to 1994-95. These optimal levels are compared with the actual levels to deduce whether Australia really does have a problem of too little saving and too large a current account deficit and if so to deduce how serious the problem is.

Other empirical analyses of Australia's current account using the intertemporal approach[2] have tested predictions from consumption smoothing models without constructing optimal series for investment, consumption and the current account, which we do in order to allow a more detailed evaluation of Australia's current account record. They also adopt an infinite horizon, unlike our model which adopts a finite horizon during which the interest rate, population growth

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[1] Fitzgerald emphasised that the prospective ageing of the Australian population added significantly to the severity of the Australian saving problem.

[2] Milbourne and Otto (1992) test the determinants of the foreign asset position, as predicted by an intertemporal model featuring Friedman's permanent income theory, of a cross section of OECD countries including Australia. Cashin and McDermott (1996) test whether the Australian current account was used to optimally smooth consumption over the period 1954 to 1994, as predicted by the intertemporal model of Obstfeld and Rogoff (1994).

and employment growth are allowed to vary in order to make the model more flexible. Having said this our objective in this paper remains mainly methodological - that is, to explore how the exercise can be done. A number of potential improvements should be considered before the empirical results are relied on for policy purposes. Some of these improvements are suggested in the conclusion.

It might be thought that an alternative approach to policy on saving is to ignore aggregates and instead rely on microeconomic reform. Under this approach the government would focus on removing distortions to saving, investment and economic transactions with overseas residents. All government expenditures and transfer decisions would be based on cost benefit analysis applied to each individual case. However, even then a decision by government on the level of public saving and thus the level of taxation, would have to be made. In as far as this decision was based on intergenerational equity, aggregate calculations along the lines put forward here would have to be made. Thus even the approach of microeconomic reform would seem to require the aggregate analysis.

In section II a basic model of the consumption balance is described. Methods developed to apply this model empirically are discussed in section III. This discussion includes the choice of the production function, the choice of the weight attached to terminal wealth in the utility function, the choice of the planning horizon, the choice of the rate of time preference, the measurement of the overseas rate of interest and the choice and measurement of other parameters and variables. In section IV the results of the application of the model to Australia for the period 1960-61 to 1994-95 are presented and discussed. A sensitivity analysis is discussed in Section V and Section VI concludes the paper.

II A Model of the Consumption Balance

In this section a basic model of the optimal levels of national saving, investment and the current account deficit is described. Here we introduce the concept of the consumption balance.

The consumption balance refers to the optimal balance of current consumption against future consumption, which implies optimal outcomes for investment, saving and the current account deficit.

Take the objective of the economy to be a social welfare function defined as a concave function of the stream of aggregate consumption levels running up to h periods in the future and of the level of wealth at the end of the h periods. Writing the aggregate level of consumption in period j as C_j and terminal wealth as W_h, the social welfare function is

$$U\left(C_1,\ C_2, \ldots C_h,\ W_h\right) \tag{1}$$

The consumption balance occurs when the social welfare function (1) is maximised subject to the production constraints and the international borrowing constraints of the economy. Assume that in period 1 a level of overseas debt, D_0, is inherited from the past and that all debt, in whatever period contracted, is required to be repaid at the common rate, m. The use of the proportion m is a way of allowing, as an approximation, for fixed interest debt with a finite lifetime. Under these assumptions, consumption in period j=1,..,h, is constrained by

$$C_j = Y_j - I_j + B_j - (m+r_1)(1-m)^{j-1}D_0 - \sum_{k=1}^{j-1}(m+r_k)(1-m)^{j-k-1}B_k \qquad j=1,\ldots,h \tag{2}$$

where Y_j is output domestically produced in period j, I_j is investment expenditure in period j, B_j is the flow of overseas borrowing in period j and r_j is the world rate of interest in period j. In this paper we adopt the simplifying assumption that each of the h interest rates, one for each period in the planning horizon, are exogenous. It will be seen that this allows the level of investment to be determined independently of the level of consumption.

Output in period j is determined by a vintage production function with "putty-clay" technology[3] of the general form:

$$Y_j = Y_1(1-\delta)^{j-1} + \sum_{k=1}^{j-1} A_k\, F_k(J_k(1-\delta)^{j-k-1};\, l_{kj}) \tag{3}$$

where F_k is the output produced from capital installed in period k; δ is the rate at which capital, once installed, depreciates; l_{kj} is the amount of labour available to work at time j on newly installed capital of vintage k, J_k; A_k is the efficiency parameter which captures technical progress; J_k is the effective capital stock installed in period k, after accounting for adjustment costs in the installation of new capital goods, and is given by

$$J_k = I_k\big(1-0.5\mu(I/K)_k\big) \tag{4}$$

where K_k is the net capital stock and μ is an adjustment cost parameter.[4] The effective capital, J_k, has a one period gestation. Hence, effective capital installed in period k-1 produces output in period k.

Terminal wealth is the capital stock after *h* periods less the accumulated overseas debt after *h* periods. Writing K_0 for the capital stock inherited in period 1 from the past, the capital stock after *h* periods of accumulation is

$$K_h = K_0(1-\delta)^h + \sum_{k=1}^{h-1} J_k(1-\delta)^{h-k} \tag{5}$$

[3] Putty-clay technology is chosen because it captures more realism than the case of malleable capital. It assumes that each vintage of capital has a fixed labour requirement until it is scrapped. This is more realistic than the malleable capital case, which assumes substitutability of an unchanged degree between machines and labour before and after the machines are installed. The putty-clay case assumes that the labour requirement of each vintage of capital is exogenous to the firm between the time it is installed and the time it is scrapped.

[4] The model of adjustment costs is adapted from McKibbin and Siegloff (1988), who broadly follow the method established by Lucas (1967) and Hayashi (1982). From (4), \$1 of investment expenditure yields \$$(1-0.5\mu(I/K)_k)$ of effective physical capital, capturing the idea that real resources are used up by the disruptions to the existing production process caused by the installation of new capital goods and the retraining of workers. 0.5 is used for analytical convenience.

There is no investment in period h because, given a one year gestation period, any investment made in period h would not augment the capital stock and generate extra output until period h + 1, which is after the end of the planning horizon.

The level of overseas debt after h periods is

$$D_h = D_0(1-m)^h + \sum_{k=1}^{h} B_k(1-m)^{h-k} \tag{6}$$

Note that overseas borrowing is possible in period h. Terminal wealth is measured at the end of period h and so can be influenced by borrowing in period h.

Given (5) and (6), terminal wealth is defined as

$$W_h = K_h - D_h \tag{7}$$

The maximisation problem which defines consumption balance may be written

$$\max_{\substack{(C_1 \ldots C_h)\\(I_1 \ldots I_{h-1})\\(B_1 \ldots B_h)\\(Y_2 \ldots Y_h)\\(W_h)}} \Gamma = U(C_1,\ C_2,\ldots,C_h,\ W_h)$$

$$\begin{aligned} &+ \sum_{j=1}^{h} \lambda_j \left[Y_j - I_j - C_j + B_j - (m+r_1)(1-m)^{j-1}\ D_0\ -\ \sum_{k=1}^{j-1} (m+r_k)((1-m)^{j-k-1}\ B_k \right] \\ &+ \sum_{j=2}^{h} \psi_j \left[(1-\delta)^{j-1}\ Y_1\ +\ \sum_{k=1}^{j-1} A_k\ F_k\!\left(J_k(1-\delta)^{j-k-1};\, l_{kj}\right) - Y_j \right] \\ &+ \phi \left[(1-\delta)^h K_0\ +\ \sum_{k=1}^{h-1}\ (1-\delta)^{h-k} J_k - (1-m)^h D_0 - \sum_{k=1}^{h} (1-m)^{h-k} B_k - W_h \right] \end{aligned} \tag{8}$$

where λ_j, j=1,...,h, ψ_j, j=2,...,h, and ϕ are Lagrange multipliers.

The first order conditions for the problem (8) are (see Guest and McDonald (1996) for their derivation) the constraints (2) and (3), the definition of terminal wealth (7) and:

$$\frac{\partial F_j}{\partial I_j} = r_j + \delta + \frac{(m-\delta)\Phi_j + \mu \dfrac{I_j}{K_j}(1-\delta)^{h-j}}{\Omega_j} \qquad j=1,..,h-1 \tag{9}$$

$$\frac{\partial U/\partial C_j}{\partial U/\partial C_h} = \prod_{k=j}^{h-1} (1+r_j) + \sum_{i=j+1}^{h-1} \left[(r_j - r_i)(1-m)^{h-i} \prod_{x=j+1}^{i-1} (1+r_x) \right] \qquad j = 1,\ldots,h-1 \tag{10}$$

$$\frac{\partial U/\partial W_h}{\partial U/\partial C_h} = 1 \tag{11}$$

where

$$\Phi_j = \sum_{i=1}^{h-j-1} \left\{ (r_{j+1} - r_j)(1-\delta)^{i-1} \left[(1-m)^{h-j-i-1} + \sum_{z=1}^{h-j-i-1} (1-m)^{z-1} \prod_{x=z}^{h-j-i-1} (1+r_{h-x}) \right] \right\} \qquad j = 1,\ldots,h-1 \tag{12}$$

$$\Omega_j = \sum_{v=j+1}^{h-1} \left\{ \left[\prod_{k=v}^{h-1} (1+r_k) + \sum_{i=v+1}^{h-1} (r_v - r_i)(1-m)^{h-i} \prod_{x=v+1}^{i-1} (1+r_x) \right] (1-\delta)^{v-j-1} \right\} + (1-\delta)^{k-j-1} \qquad j = 1,\ldots,h-1 \tag{13}$$

The (h-1) equations (9) determine the optimal levels of investment in each period up to period h-1. Note that the socially optimal levels of investment are determined independently of the utility function. This is the usual result for a small open economy for which interest rates are exogenously determined. Once the investment levels are determined, then the levels of output for all periods from period 2 up to period *h* can be determined by the h-1 equations, (3). (Because investment has a one period gestation and employment is assumed exogenous, output in the first period is assumed to be exogenous.)

The h-1 equations (10) relate the pattern of consumption levels over the planning horizon to the rates of interest. We can write these as $C_k = \theta_k C_h$ for k=1,..,h-1, where the θ_k are determined by the interest rates for periods 1 to h-1 and the form of the utility function. The transversality condition (11), equating the marginal utility of terminal wealth and the marginal utility of terminal consumption, relates the level of terminal wealth to C_h. Given this, the optimal level of consumption in period h, the optimal levels of borrowing and the optimal level of terminal wealth are then determined by the h accounting relations (2), the transversality condition (11) and the definition of terminal wealth (7).

III Functional Forms and Methods of Application of the Model.

A major problem in applying the model of the consumption balance is that usual functional forms for the production function and the utility function generate series for optimal investment, and to a lesser extent consumption, which exhibit much greater volatility than the actual series.[5] It is, however difficult to think of convincing arguments for why the volatility of optimal series should be greater than the volatility of actual series.(For further discussion of this see Guest and McDonald(forthcoming)). In order to reduce the volatility of the series for the optimal level of investment, we introduce two additional assumptions, following McKibbin and Sieglof (1988). Firstly, we assume that the proportion Π of investment is determined according to the first order condition (9), denoted I^{opt}, and that the proportion $(1-\Pi)$ of investment is subject to liquidity constraints, denoted by I^{liq}, and is therefore determined by the level of retained earnings. We use output as a proxy for retained earnings. These assumptions mean that the total of constrained optimal investment, denoted by $\hat{I}$, is given by:

$$\hat{I}_j = \Pi I^{opt}{}_j + (1-\Pi) I^{liq}{}_j \tag{14}$$

[5] For a discussion and explanation of the volatility in models of aggregate optimal investment see, for instance, Bertola and Caballero (1994) and Guest and McDonald (forthcoming).

where

$$\left(\frac{I^{liq}}{K}\right)_j = \gamma_0 + \gamma_1\left(\frac{Y}{K}\right)_j \qquad (15)$$

The second additional assumption is that half of the level of investment, $\hat{I}$, is subject to a one year decision lag so that half of the investment expenditure given by (14) occurs in the period of the investment decision and the remaining half occurs in the following year.[6] This lag may reflect lags in recognising changes in investment profitability (that is changes in (9) or (15)) and/or lags in making investment decisions. The resulting smoothed series for optimal investment, I_j^*, is a two-period moving average of the unsmoothed series, $\hat{I}$:

$$I_j^* = 0.5\hat{I}_j + 0.5\hat{I}_{j-1} \qquad (16)$$

The Cobb-Douglas form is chosen for the vintage production function (3):

$$Y_j = (1-\delta)^{(j-1)}Y_1 + \sum_{k=1}^{j-1}(1-\delta)^{(j-k-1)}A_kJ_k^{\alpha}(L_{k+1}-(1-\delta)L_k)^{1-\alpha} \qquad (17)$$

$$j = 1,..,h$$

where L_k is the aggregate level of employment in period k and the term, $L_{k+1}-(1-\delta)L_k$, is the amount of labour available to work on effective capital newly installed. It is equal to the increase in the labour force in each time period, $L_{k+1} - L_k$, plus the amount of the previous period's

[6] This is not to be confused with the one-period gestation between the expenditure on investment and the resulting output generated.

employment released from working on old capital which has depreciated by δL_k. The term L_{k+1} - $(1-\delta)L_k$ replaces the term l_{kj} in (3) since the amount of labour working on capital of a particular vintage is not readily observable (see Guest and McDonald (1995) for a derivation of vintage production function, (17)).

$$= \sum_{j=1}^{h} \left\{ \frac{N_j \left(\frac{C_j - \overline{C}_j}{N_j} \right)^{1-\beta} (1+\rho)^{1-j}}{1-\beta} \right\} + \frac{N_h \omega \left(\frac{W_h}{N_h} \right)^{1-\Psi} (1+\rho)^{1-h}}{1-\Psi} \qquad j = 1, \ldots, \tag{18}$$

$$\beta,\ \Psi,\ \omega > 0,\ C_j \geq \overline{C}_j \geq 0\ ,\ W_h \geq 0$$

For the utility function the additive, constant elasticity form is chosen:

where N_j is the population in period j; ρ is the rate of time preference; and $\overline{C}_j$ is the minimum subsistence or habit level of consumption in year j and in year 1 is assumed to be 66% of actual consumption expenditure for j=1 (since actual expenditure in year 1 of a plan is given).[7] For years j=2,..,h we assume that $\overline{C}_j$ grows at the rate of growth of optimal output. Introducing a subsistence level of consumption has the effect of reducing the volatility in the series for optimal consumption. In (18) total utility is population times per capita utility. The non-negativity constraint on C_j and W_h is imposed to ensure $\frac{\partial U}{\partial C_j}, \frac{\partial U}{\partial W_h} > 0$ over the admissible domain of C_j

[7] This is the estimate of Lluch (1977) for Australia. More recent estimates for the U.S are given by Constantinides (1990) and Ferson and Constantinides (1991), whose estimates of the habit rate of consumption are approximately 0.80 of recent actual consumption. If consumption behaviour in Australia is comparable with the U.S. then our assumed value of 0.66 may be on the conservative side.

and W_h.

From (18)

$$\frac{\partial U}{\partial C_j} = N_j^{\beta} (C_j - \overline{C}_j)^{-\beta} (1+\rho)^{1-j} \tag{19}$$

and

$$\frac{\partial U}{\partial W_h} = N_h^{\psi} \omega W_h^{-\psi} (1+\rho)^{1-h} \tag{20}$$

and from the condition (10), consumption levels in each period j=1,..,h-1 relative to the consumption level in period h are

$$C_j = \theta_j (C_h - \overline{C}_h) + \overline{C}_j \qquad j=1,\ldots,h-1 \tag{21}$$

where

$$\theta_j = \left(\frac{N_j}{N_h}\right)(1+\rho)^{\frac{h-j}{\beta}} \left\{ \prod_{k=j}^{h-1}(1+r_k) + \sum_{i=j+1}^{h-1}\left[(r_j - r_i)(1-m)^{h-i}\prod_{x=j+1}^{i-1}(1+r_x)\right]\right\}^{-\frac{1}{\beta}} \tag{22}$$

As (22) shows, if the interest rate varies over the horizon then the degree of consumption smoothing is modified by the requirement that a proportion m of debt has to be repaid each period. If, alternatively, the interest rate is constant over the horizon then m has no influence on consumption smoothing.

Substituting (19) and (20) into (11) implies that terminal wealth is related to consumption in period h by

$$W_h = n^{\psi-\beta} \omega^{\frac{1}{\psi}} (C_h - \overline{C}_h)^{\frac{\beta}{\psi}} \tag{23}$$

To ensure that the optimal path of saving is sustainable in the sense that it does not imply a run-down of wealth by the end of the horizon, an endpoint condition on terminal wealth is imposed. This condition is generated by setting ω, the weight attached to terminal wealth relative to consumption, in the following way. Assuming that ψ=β, (23) implies a terminal wealth to consumption ratio given by

$$\frac{W_h}{C_h - \overline{C}_h} = \omega^{\frac{1}{\beta}} \tag{24}$$

Equation (24) implies that the terminal wealth to consumption ratio is determined by the parameters ω and β. Using this relation the value of ω is set such that $\frac{W_h}{(C_h - \overline{C}_h)}$ is equal to the actual (exogenous) value of this variable in the first year of the plan, that is, $\frac{W_1}{(C_1 - \overline{C}_1)}$.

Thus:

$$\omega = \left(\frac{W_1}{C_1 - \overline{C}_1} \right)^{\beta} \tag{25}$$

Setting the value of ω in this way ensures that the ratio of terminal wealth to consumption in the final year of the plan is equal to the ratio of wealth to consumption in the initial year of the plan.

With the additive constant elasticity utility function, values for the rate of time preference outside a fairly narrow range can yield extreme ratios of consumption to output (C/Y) and debt to output (D/Y) in optimal plans with long planning horizons. Extreme values of D/Y are unacceptable because they are inconsistent with the assumption of the model that the interest rate is not influenced by the level of foreign debt. A very high value of D/Y may cause foreign lenders to impose a risk premium in the interest rate. In the opposite extreme case where D/Y is a large negative number, the economy has a large stock of foreign assets which would imply a lower cost of borrowing from overseas.[8] To rule out these possibilities the value of ρ is restricted in the following way. As indicated above, if the interest rate and the growth rate of population are constant over the time horizon, from (21) and (22) consumption grows at the rate:

$$\Theta = (1+\nu)\left[\frac{1+r}{1+\rho}\right]^{\frac{1}{\beta}} - 1 \tag{26}$$

Since interest rates and population growth are constant beyond 1994-95 and 2050-51, respectively, (26) gives the asymptotic growth rate of consumption. The value of ρ is chosen so that the asymptotic growth rate of consumption, Θ , equals the growth rate of output, γ, at the end of the horizon.[9] Setting $\gamma = \Theta$, gives the value for ρ:

$$\rho = \frac{(1+\nu)^{\beta}(1+r)}{(1+\gamma)^{\beta}} - 1 \tag{27}$$

This restriction on ρ does not rule out the possibility of unacceptable values for D/Y but it does reduce the range of values which D/Y can take for given values of parameters and exogenous variables, thereby reducing the possibility of unacceptable values D/Y.[10] With this restriction and the exogenous variables used in the simulations which we conduct in this paper, unacceptable outcomes such as negative consumption or exploding debt do not occur.

The consumption balance is described by equations, (2), (7), (9), (12), (13), (17), (21), (22) and (23), describe the consumption balance for the special case of a constant elasticity utility function, (18), and a Cobb-Douglas vintage production function with adjustment costs, (17).

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[8] Blanchard and Fischer (1989, p.85) give this argument for imposing the restriction that the rate of time preference be equal to the interest rate.

[9] Since the horizon is long, the value of γ is approximately equal to the asymptotic growth rate of output.

[10] In the special case where the rate of technical progress is zero and all endogenous variables are expressed in per capita units, (27) reduces to $\rho = r$, the restriction in Blanchard and Fisher (1989) cited above.

Calculating the Optimal Values for the Consumption Balance

The values chosen for the parameters are summarised in Table 1 below. These values are reasonable values for the Australian economy (for further discussion see Guest and McDonald (1996)). Assumptions and methods of determining values of the exogenous variables N_j, L_j, r_j, K_j, D_j and A_j and the parameters are discussed in the Data Appendix.

Having specified explicit functional forms and values of the parameters and exogenous variables, the optimal levels of consumption, investment and the current account surplus can be calculated for the period 1960-61 to 1994-95. This is done in the following way. Take a particular year (say 1960-61) and a particular set of assumed values for the parameters and the exogenous variables and calculate the sequence over the planning horizon of consumption, investment and the current account surplus that yield the consumption balance. The values of C, I and B for the first period of the optimal sequence give the consumption balance for that year (say for 1960-61). This procedure is repeated for each year in the planning period 1960-61 to 1994-95 giving a sequence of outcomes of the consumption balance.

Table 1

δ, the depreciation rate	0.051
α, the partial elasticity of output with respect to capital	0.370
m, the proportion of debt to be repaid in each year	0.150
β, the reciprocal of the elasticity of intertemporal substitution	2.000
ψ, the reciprocal of the elasticity of substitution between W_h and C_h	2.000
μ, the adjustment cost parameter	3.890
ρ, the rate of time preference	(varies between plans from 0.0121 to 0.0139)
ω, the weight attached to terminal wealth in the utility function	(varies between plans)
h, the planning horizon	100 years (see below)
Π, the proportion of investment not subject to liquidity constraints	0.50 [11]
$\overline{C_j}$, subsistence consumption	0.66 of actual consumption
γ_0, γ_1, parameters in determining liquidity constrained investment	-0.045, 0.359 respectively
technical progress (growth rate of A_j)	0.01

Under this procedure optimal levels of C, I and B for a particular year will be typically calculated several times and these calculated values may differ.[12] For example with a 2 year

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[11] McKibbin and Siegloff (1988) econometrically estimated a value of 0.10 for this parameter for Australia, implying in the context of this paper that 10 percent of investment is determined by equation (9) and 90 percent of investment is based on current profits as a result of liquidity constraints. We choose a value of 0.50 for Π in order to give somewhat more weight to unconstrained investment. This value is sufficient to give a mean and coefficient of variation of the optimal investment series which is approximately equal to that for the actual series.

planning horizon the calculation of the consumption balance for 1960-61 gives optimal levels of C, I and B for 1960-61 and 1961-62. Then, the calculation of the consumption balance for 1961-62 gives optimal levels of C, I and B for 1961-62 and 1962-63. The overlapping year, 1961-62, has two sets of optimal values of C, I and B. The second set may, indeed usually will, differ from the first set. Pushing forward the base year adds information from the future, drops out some of the information from the past and may cause some other information to be revised. This procedure is a reasonable reflection of decision makers re-optimising as new information becomes available.

Choosing the Length of the Finite Planning Horizon.

There is a case for an infinite horizon on the grounds that this takes into account the utility in all future years. Although the horizon in this paper is finite, the length of the horizon is chosen to be long enough that the optimal levels today of the variables will not be significantly affected by extending the horizon by an additional year. This criterion ensures that the optimal outcomes effectively capture the utility generated in all future years. Our method allows a tractable solution to calculating optimal outcomes which are not restricted by assumptions commonly made in infinite horizon models that either the economy is in a steady state throughout the horizon, with exogenous variables such as interest rates, population growth and employment growth, being constant throughout the horizon; or that the economy begins and ends in a steady state (see, for example, Cutler et.al., 1990).

For the simulations a planning horizon is chosen such that the value of the optimal current account as a ratio to GDP, CAD/Y, for the initial year is within a specified degree of tolerance of its asymptotic value.[13] The degree of tolerance is set at 0.005.Chart 3 shows values of the optimal

[13] For the purposes of determining the impact of the planning horizon on the consumption balance, the optimal CAD is chosen as an summary indicator of the consumption balance, because the optimal CAD is a residual which is determined by the optimal values of C and I.

CAD/Y for 1960-61 for planning horizons from 10 years to 300 years [14]. It is clear that the optimal size of the current account deficit is sensitive to the length of the planning horizon. A horizon of 10 years implies an optimal CAD/Y for 1960-61 of 0.166; a 50 year horizon yields a value of 0.103, while a 100 year horizon yields a value of 0.096. Chart 3 shows that the value of CAD/Y for 1960-61 approaches an asymptote equal to 0.092 as the length of the planning horizon is increased. For 1960-61 plans, a planning horizons of 100 years or more satisfies our sensitivity test. On this basis, a planning horizon of 100 years is chosen as the appropriate planning horizon to be applied for all plans.

Our method for choosing the planning horizon ensures that the optimal outcomes in the initial year are not very sensitive to the value chosen for terminal wealth. Given the arbitrary basis for the choice of terminal wealth, this insensitivity is an additional advantage of our method for choosing the planning horizon.

IV The consumption balance for Australia from 1960-61 to 1994-95.

Using the model of section II and the methods of application described in section III, the consumption balance is calculated for Australia for the period 1960-61 to 1994-95. The results are reported in Charts 4 and 5. Chart 4 compares the optimal and the actual values of the ratios to GDP of consumption, investment and the current account deficit for Australia over the period 1960-61 to 1994-95. Chart 5 plots the optimal saving to GDP ratio from 1960-61 to 2050-51.[15] In Chart 5, the values for 1960-61 to 1994-95 are the year 1 values for the plan commencing in

[14] The reason for choosing 1960-61 is that, compared to other plans, the 1960-61 plan incorporates the longest period of the plan for which the actual values of exogenous variables are known. This implies that there is more variability in the data for this plan than for other plans, which in turn means that the optimal CAD/Y in the first year of the plan takes longer to settle down, for given initial values of exogenous variables and parameter values. Therefore, if the optimal CAD/Y settles down within the specified degree of tolerance for a certain horizon for the 1960-61 plan, then it will also settle down within the same horizon for subsequent plans, for given initial values and parameter values.

[15] The optimal saving ratio is given by $(S/Y)_j = 1-(C/Y)_j-(rD_{j-1}/Y_j)$, where rD_{j-1} is the income payable on foreign liabilities. Equivalently, $(S/Y)_j = (I/Y)_j-(CAD/Y)_j$.

each year whilst for 1995-96 to 2050-51 the values are the optimal values for each year of the last plan, which commences in 1994-95. Table 2 gives the means and standard deviations for the actual and socially optimal series of investment, consumption, the current account deficit and saving as shown in Charts 4 and 5.

TABLE 2

		Full sample 1960-61 to 1994-95		**Sub-period 1974-75 to 1994-95**	
Series		**mean**	**S.D.***	**mean**	**S.D.**
Investment	actual	0.248	0.021	0.236	0.017
	optimal	0.245	0.029	0.228	0.023
Consumption	actual	0.754	0.018	0.764	0.012
	optimal	0.784	0.028	0.769	0.019
CAD	actual	0.033	0.017	0.039	0.013
	optimal	0.041	0.050	0.015	0.038
saving	actual	0.216	0.032	0.196	0.024
	optimal	0.204	0.025	0.213	0.021

* standard deviation

Inspection of Charts 4 and 5 suggests that in the period under study, 1960-61 to 1994-95, three sub-periods can be discerned. In the sub-period 1960-61 to 1973-74 there was excessive saving and too little overseas borrowing (too small a current account deficit)[16]. In the second sub-period, from 1974-75 to 1985-86, there was too little saving and excessive overseas borrowing.

[16] In identifying the current account deficit with overseas borrowing it should be born in mind that the actual current account deficit, as measured by national accounting statistics, overstates slightly in an inflationary period the amount of overseas borrowing in real terms. This is because of the reduction in the real value of overseas debt denominated in nominal amounts. This overstatement does not apply to the optimal current account deficit as measured in this paper.

In the remaining years, 1986-87 to 1994-95, the optimal levels of saving and overseas borrowing fluctuate around their actual levels. Taking the full sample period, 1960-61 to 1994-95, Australia did not under-save. Rather, the average level of actual saving was 1.2% of GDP above the average socially optimal level (Table 2). In fact, for the earlier sub-period from 1960-61 to 1973-74 Australia over-saved by 5.3% of GDP. However, for the sub-period 1974-75 to 1994-95, Australia did under-save by an average of 1.7% of GDP. This result is consistent with the popular perception of under-saving since the mid-1970's. Similarly, over the full sample period Australia did borrow excessively from overseas -overseas borrowing was 0.8% of GDP below the optimal level. Again, however, in the period since the mid 1970's overseas borrowing by Australia exceeded the optimal level by an annual average of 2.4% of GDP.

The degree to which Australia has made use of world capital markets to smooth consumption is indicated by the correlation coefficient between the actual and optimal levels of saving. For the full period 1960-61 to 1994-95 the coefficient is 0.54 which is statistically less than 1 (at the 1% level). This suggests that Australia, over the full period, has failed to make optimal use of the world capital market to smooth consumption. In the first sub-period, from 1960-61 to 1973-74, Australia could have enjoyed higher economic welfare by consuming more and financing this by increasing its overseas indebtedness. In the second sub-period, from 1974-75 to 1985-86, higher economic welfare could have been achieved by reducing investment with a commensurate reduction in overseas indebtedness. However, for the period 1960-61 to 1984-85, the period before which capital markets were deregulated, the correlation coefficient between actual and optimal saving is 0.25, compared with 0.69 for the post-deregulation period, 1985-86 to 1994-95. The correlation coefficient for the pre-deregulation period is statistically less than that for the post-deregulation period (at the 1% level). This implies that the suggestion that Australia has failed to make full use of world capital markets is not so apparent for the period from 1985-86 to 1994-95, which is also the period since capital markets had been deregulated and had become deeper. This suggests that deregulation and the deepening of capital markets has had a beneficial impact on attaining the consumption balance.

Fluctuations in the optimal consumption ratio (Chart 4), and therefore the optimal saving ratio (Chart 5), are determined mainly by the pattern of interest rates through the horizon. The influence of the pattern of interest rates on consumption smoothing within a given plan is evident from equations (21) and (22). Chart 6 illustrates the importance of the interest rate in driving fluctuations in optimal saving by plotting the one-period changes in the interest rate and in the optimal saving rate. It is clear from Chart 6 that when the interest rate falls the optimal saving rate also tends to fall and when the interest rate rises the optimal saving rate tends to rise. Further evidence is found in a simulation in which the interest rate is held constant over the planning period. The result is a reduction in the standard deviation of $(C/Y)_1$ from 0.028 to 0.018.

V Sensitivity Analysis.

In this section we consider the sensitivity of optimal outcomes to changes in the assumed values of key parameters and exogenous variables. Table 3 summarises the results using the plan for 1994-95.

TABLE 3

Sensitivity of Optimal Outcomes for 1994/95

	Parameter or exogenous variable	Baseline value	Perturbed value	S/Y baseline = 0.191	I/Y baseline = 0.293	CAD/Y baseline = 0.1
C/C	the ratio of subsistence to actual consumption	0.66	0.80 (ρ=0.013)	0.195	0.293	0.099
β	elasticity of intertemp. substitution		4.00 (ρ=-0.018)	0.191	0.293	0.102
m	rate of debt repayment	0.15	0.10 (ρ=0.013)	0.191	0.294	0.103
δ	rate of depreciation	0.051	0.10 (ρ=0.013)	0.222	0.244	0.222
μ	adjustment cost parameter	3.89	5.0 (ρ=0.013)	0.185	0.262	0.077
Π	proportion of investment not liquidity constrained	0.5	0.10 (ρ=0.013)	0.188	0.259	0.071
r_j	the world real interest rate	0.040 for j=1 0.0451 for j=2,..,h	base - 0.01 (ρ=0.013)	0.199	0.303	0.105
N_j/N_{j-1} $=L_j/L_{j-1}$	one plus population and employment growth rate	ABS Series C	base+0.01 (ρ=-0.007)	0.202	0.294	0.092
A_j/A_{j-1}	one plus the rate of technical progress	1.01	1.02 (ρ=-0.018)	0.130	0.321	0.192
α	capital elasticity of output	0.37	0.32 (ρ=0.015)	0.281	0.243	-0.039
ρ	rate of time preference	0.013 see above				

The size of the perturbation from the baseline value was chosen to yield a perturbed value which is close to the extreme end of reasonable values for the Australian economy. Table 3 shows that the impact on the optimal saving ratio for 1994/95 of the perturbations in the parameters is quite small with the exception of perterbations to the rate of technical progress and the capital elasticity of output. We conclude that the results of the model are quite robust with respect to reasonable changes in values of most of the parameters.[17]

The intuition for the sensitivity with respect to the rate to technical progress is as follows. A higher rate of technical progress implies higher wealth and therefore higher consumption throughout the plan. Given that the initial level of income is exogenous, higher initial consumption implies a lower saving ratio in the first year of the plan. This effect is partially offset by a fall in the rate of time preference (through (27)). A doubling of the rate of technical progress from 1% to 2% leads to a fall of 6.1% points in the optimal saving ratio. With respect to the capital elasticity of output, a lower value reduces the marginal productivity of investment and hence the level and growth rate of investment, which reduces terminal wealth and therefore consumption in all years of the plan. An additional, but opposite and weaker, effect occurs through the effect of investment growth in increasing ρ, the rate of time preference. The net effect is to increase the saving ratio by 9 percentage points.

The impact of a recession on optimal saving.

We simulate a recession by reducing the level of employment by 1 percentage point below the baseline case for the first 5 years of the plan commencing in 1994-95. We also reduce the exogenous level of output in 1994-95 by 0.63%, which is one percent times the elasticity of output with respect to employment. The effect is to reduce the optimal level of saving for 1994-

[17] We also conducted simulations in which the parameters were shocked by a similar magnitude but in the opposite direction to those reported in Table 3. The impact on the optimal outcomes was of a similar size except for the two cases where the impact in Table 3 is large. In these two cases, because the subsistence level of consumption damps falls in consumption relative to rises in consumption, the large increase in consumption for the perterbation in one direction is not matched by a large decrease in consumption for the perterbation in the other direction.

95 by 0.4 percent of GDP, from 0.191 to 0.187; and increase the CAD by 0.8 percent of GDP from 0.102 to 0.110.[18] This impact on optimal saving reflects the optimal smoothing of consumption over the plan.

VI Conclusion

In this paper the theory of the optimal level and disposition of saving in a small open economy has been applied to the Australian economy. The model used to apply the theory is characterised by a number of important assumptions. The model assumes a finite time horizon. The length of the finite planning horizon was chosen to be long enough that the addition of an extra year would have an insignificant effect on the optimal values in the initial year. Terminal wealth was constrained to be no less than initial wealth (as a ratio of consumption). This assumption ensures that the optimal saving profiles are sustainable in that they do not imply a run-down of wealth by the end of the horizon. Furthermore, the criterion for choosing the length of the horizon ensures that changes in the value of terminal wealth will have insignificant effects on initial optimal values. The values of exogenous variables are allowed to fluctuate for an initial period of the horizon in order to reflect available forecasts. For both investment and consumption a number of procedures were adopted to smooth the optimal series so that their standard deviations were similar to those of the actual series. This was done to avoid an implausible degree of volatility in the optimal series. For investment these procedures were: the use of a vintage production function, adjustment costs, liquidity constraints, and recognition and action lags in the investment decision. For consumption, a subsistence level of consumption was specified. However, some of these smoothing assumptions, such as liquidity constraints and decision lags, may be questioned on the grounds that they are not socially optimal. On the other hand it is hard to see what set of institutions could be developed to make the removal of these features of the real world feasible. Thus the smoothed series can reasonably withstand the criticism that they are

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[18] The increase in the CAD also reflects an increase in the optimal investment ratio caused by the fact that the level of investment falls by a little less than the fall in the exogenous level of output.

sub-optimal as a result of these assumptions.

Even with the smoothed series for investment and consumption, the series for the optimal current account deficit has a much higher standard deviation than that of the actual series. This reflects some large optimal current account deficits or surpluses in some years, in the order of 10 percent of GDP. Some may question the social optimality of such outcomes.

Using the model to evaluate the Australian record 1960-61 to 1994-95, two main conclusions emerge. Firstly, while Australia under-saved by an average of 1.7% of GDP from 1974/75 to 1994/95, it over-saved by an average of 5.3% of GDP in the earlier period from 1960-61 to 1973-74. Secondly, Australia did not make optimal use of world capital markets to smooth consumption in the period from 1960-61 to 1984-85; although there is less evidence for this since 1984-85, suggesting that deregulation of capital markets may have had a beneficial effect on achieving the consumption balance. The sensitivity of the optimal outcomes to some parameters and variables suggests a caveat ought to be attached to these results.

We draw attention to several potential improvements, some of which may reduce the volatility in the optimal outcomes and improve the robustness of the outcomes to changes in assumptions. Firstly, there is the obvious attraction of using a disaggregated model - for instance, manufacturing and non-manufacturing sectors. Secondly, a more sophisticated modelling of consumption would allow for various groups of people (generations and dependents). The conclusion by FitzGerald (1993) that Australia is undersaving was largely based on the prospective ageing of the Australian population. If an ageing population were included in the model of this paper, the resulting pattern of the consumption balance would yield, presumably, an even greater level of under-saving in recent years. A third extension would allow for a risk premium in the interest rate to reflect the observation that interest rates vary positively with the size of a country's foreign debt. This would imply higher interest rates which may reduce the sensitivity of investment and saving to small changes in the level of those interest rates.

DATA APPENDIX

Determining parameter values.

The value of α.

The parameter α is the elasticity of output with respect to capital. An upper bound for α can be inferred from the data on the wages share of income, which averaged 0.5744 for Australia over the period 1966-1994.[19] Given some degree of imperfect competition, labour is paid less than its marginal product, which implies that the output elasticity of labour, $1-\alpha$, is greater than the wages share of income. On this basis a lower bound for $(1-\alpha)$ is 0.5744 implying an upper bound for α of 1-0.5744=0.4256. On the plausible assumption that market power rents are 5 percentage points of GDP, the value of α is set at 0.37. This value is broadly consistent with the overseas literature using vintage production functions.[20]

The rate of depreciation, δ.

The concept of depreciation adopted is the one used by the ABS. Depreciation is defined by the ABS[21] as consumption of fixed capital. "It is the result of normal wear and tear, loss in value due to unforseen obsolescence, and the normal amount of accidental damage which is not made good by repair."[22] Depreciation is measured as the change in the present discounted value (PDV) of the future service potential of the asset. The discount rate used is the internal rate of return of the asset. The ABS adopts the convention of a straight line (prime cost) depreciation

[19] From ABS data service, DX.

[20] There are no Australian estimates of α using vintage production functions.

[21] ABS Catalogue 5221.0.

[22] ABS Catalogue 5221.0 - explanatory notes.

function in order to calculate the depreciation charge each year. Using figures for end-year gross capital stock and consumption of fixed capital for both private enterprises and public authorities, the average straight line depreciation rate from 1966-67[23] to 1994-95 is 0.033. Using figures for end-year net capital stock[24] and consumption of fixed capital, the average reducing balance depreciation rate is 0.051. Since our model assumes a reducing balance depreciation function, the value for depreciation adopted for all years is 0.051.

The adjustment cost parameter, μ.

In choosing a value for μ we follow the lead in the Australian study by McKibbin and Sieglof (1988). Although they conduct simulations for several different values of the adjustment cost parameter, their "prior belief" is that adjustment costs represent approximately 20% of investment expenditure. That is, $1 of investment expenditure yields 80 cents of effective physical capital. In our notation, this implies that $0.5\mu(I/K)_j=0.2$.[25] In determining a value for $(I/K)_j$, we use the average actual value of (I/K) for the sample period: 1960-61 to 1994-95. This value is approximately 0.10, which implies a value for μ of 4.0.

The rate of debt repayment, m

The parameter, m, is set at 0.15, implying that 90 percent of a loan would be repaid after 14 years. Although repayment plans for project finance differ widely, the assumption here is

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[23] This series for capital stock begins in 1966-67.

[24] Net capital stock is defined as gross capital stock less accumulated capital consumption - that is the written down value of the capital stock, which can be used to calculate the reducing balance depreciation rate.

[25] We represent adjustment costs a little differently from McKibbin and Siegloff. In their model

$I_s = J_s \left| 1 + 0.5\phi \left| \frac{I_s}{K} \right| \right|$ where $0.5\phi\left(\frac{J^2{}_s}{K_s} \right)$ =cost of installing J additional units of capital (0.5 is used for analytical convenience); and where is the adjustment cost parameter. This can be compared to our representation in which $J_k = I_k(1\text{-}0.5\mu(I/K)_k)$. We prefer this ϕ form because it expresses more directly physical capital, J_k, as equal to investment expenditure after deducting adjustment costs.

consistent with a typical project finance repayment plan.

The Choice of the Baseline Values for Variables

The calculation of r is described in McDonald, Tacconi and Kaur (1991). This interest rate is a real world rate which measures the social opportunity cost of consumption for Australia. It is based on the 10 year government bond rates for three countries, USA, UK, and West Germany. These rates were adjusted for errors in forecasting inflation in these three countries and then deflated by the Australian consumer price index expressed in the currency of the respective country. The resulting country real rates of interest were combined in a weighted sum, where the weights were calculated to minimize the variance (risk) of return from the portfolio of bonds from the three countries.[26] This weighted sum is called the overseas rate of interest. It is a real rate and is plotted in Chart 1. The chart shows that the rate of interest has followed a pronounced cyclical pattern in the 1970's and 1980's. The average value over the entire period of the overseas rate of interest is 4.55 percent. This average is also shown in Chart 1. The maximum value of the interest rate was 9.15 percent in 1981-82 and the minimum value was 0.66 percent in 1971-72.

Assumptions must be made about the values of exogenous variables beyond 1994-95 to the end of the planning horizon. The interest rate is assumed to adjust from the rate of 4.03% in 1994-95 to 4.51% in 1995-96 and thereafter, to the end of the planning horizon. 4.51% is the average rate from 1960-61 to 1994-95.

Values for the population, N_j, from 1995-96 to 2050-51 are the ABS projected values given by series C.[27] For years beyond 2050-51 population is assumed to grow at the average annualised rate of growth from 2040-41 to 2050-51. Employment is assumed to grow at the same

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[26] These weights are as follows:0.43 for the U.S, -0.01 for the U.K. and 0.58 for Germany.

[27] ABS Catalogue No. 3204.0. There are three series of population projections and each series is based on alternative assumptions about fertility rates and immigration rates. Series C is adopted here because it gives projected values of population which are in between the growth rates of the other two series.

rate as the working age population from 1995-96 to 2050-51 according to Series C; and for years beyond 2050-51 the assumption is consistent with that for population - that is, the average annualised growth rate of the working age population for 2040-41 to 2050-51 is assumed.

In the calculation of wealth, the series of Australian liabilities to overseas residents include fixed interest and equity. For the net capital stock, the ABS estimates are adjusted, following the approach in McKibbin and Sieglof (1988), to reflect the assumption that capital is costly to adjust. The ABS series assumes that \$1 of investment expenditure yields \$1 of additional capital stock, whereas (4) implies that \$1 of investment expenditure yields less than \$1 of additional capital stock. The adjusted net capital stock series is constructed as follows. The net capital stock in period j+1 is given by:

$$K_{j+1} = K_j(1-\delta) + J_{tj} \tag{A.1}$$

Substituting (4) into (A.1) yields:

$$K_{j+1} = K_j(1-\delta) + I_j\left(1-0.5\mu\left(\frac{I}{K}\right)_j\right) \tag{A.2}$$

Given an initial value of K_j (j=1960-61), values of I_j and a value for μ and δ, the series for K_j is constructed from (A.2).

The efficiency parameter A_j may be calculated from the production function, (17), by substituting actual values of Y_j, Y_{j+1}, I_j, K_j, L_j and L_{j+1} into

$$A_j = \frac{Y_{j+1} - Y_j(1-\delta)}{\left[I_j\left(1-\mu\frac{I_j}{K_j}\right)\right]^{\alpha}[(L_{j+1}-(1-\delta)L_j)]^{1-\alpha}} \tag{A.3}$$

In this way, the values of A_j are calculated for each year from 1960-61 to 1993-94, given the actual values of Y_j, L_j and I_j for each year.[28] The series for A_j is shown in Chart 2. It is clearly very volatile implying a volatile rate of technical progress. This is because the measured rate of technical progress varies due to cyclical factors, in particular labour hoarding in economic downturns, as well as variations in "true" technical progress. The unobservable "true" rate of technical progress may reasonably be assumed to vary less than the measured rate. Hence, in the simulations that follow, the values of A_j are smoothed by running a log-linear trend through the observed series (see Chart 2). The log-linear trend growth rate of A_j, a, is 1.008%. This rate of technical progress is assumed to remain constant for all years from 1960-61 to the end of the planning horizon.

[28] A value of A for 1994-95 is not calculated because this would require data for Y and L for 1995-96.

Actual values for the Australian economy[29]

	A_1^*	L^*	I^{**}	Y^{**}	r^*	N^*	K	D^{**}	CAD	C^{**}
1960-61	49.24	150.07	29395	117163	4.04	10508	35376	2767	5741	87370
1961-62	65.27	153.95	29984	120360	3.76	10701	37750	2869	120	90186
1962-63	64.55	158.79	32036	127771	2.82	10907	41261	3146	3578	95292
1963-64	63.26	165.78	35373	136586	1.75	11122	43017	3082	546	101013
1964-65	34.38	172.63	39852	145219	1.84	11341	45651	3807	5518	106506
1965-66	78.07	186.09	42134	148922	2.38	11599	47407	4279	6106	111299
1966-67	57.38	188.70	42898	158770	2.83	11799	57715	4810	4446	117269
1967-68	99.65	193.40	45237	165247	3.25	12009	63142	5203	7271	124833
1968-69	71.01	195.20	49074	179489	3.90	12263	69614	5787	6103	130295
1969-70	61.48	199.10	51653	188848	3.44	12507	77409	6151	4155	137571
1970-71	60.57	207.80	54584	199074	0.89	13067	87293	6520	4181	143247
1971-72	71.37	214.50	56363	207809	0.66	13304	99030	6066	1455	148857
1972-73	55.45	215.30	57138	214875	3.17	13505	116187	5199	-3653	156758
1973-74	80.96	222.10	58847	221962	4.03	13723	146513	5645	3773	166023
1974-75	114.73	219.20	56070	227379	12.94	13893	182338	6783	4093	173191
1975-76	75.99	215.40	58970	237354	6.35	14033	215310	7237	4509	180250
1976-77	63.52	216.08	59991	244607	6.56	14192	245615	9222	6849	185060
1977-78	87.41	214.15	59334	246049	4.86	14359	272947	11869	7874	189105
1978-79	69.88	220.07	63339	261707	4.08	14516	309009	14629	8898	195662
1979-80	61.52	222.20	63626	268292	4.81	14695	354099	36332	4293	200757
1980-81	91.29	229.16	69826	276102	7.7	14923	410716	32711	10768	209283
1981-82	55.26	227.79	74398	284949	9.5	15184	475588	38576	16527	216349
1982-83	91.26	220.43	66165	278534	8.32	15394	525464	48417	11141	219674
1983-84	68.66	224.34	68018	293143	8.43	15579	568525	55166	11139	225813
1984-85	70.09	236.69	74295	307268	7.78	15788	635065	77558	16285	235267
1985-86	66.00	247.01	77474	321035	4.61	16018	711574	97304	19583	244509

[29] With the exception of the interest rate, r, which is a world rate.

1986-87	76.40	250.23	76049	327284	3.15	16263	786009	117377	15382	247790
1987-88	66.74	259.64	81200	342885	4.83	16538	871414	124873	12687	256994
1988-89	85.97	268.87	89828	354515	6.71	16814	974704	148690	18789	267505
1989-90	60.76	270.48	89553	366909	7.55	17065	1053761	164268	20914	279783
1990-91	90.78	268.45	80515	366448	6.67	17284	1089110	184769	16124	283729
1991-92	105.58	264.89	75659	371766	4.89	17489	1110283	198898	12268	290943
1992-93	81.71	262.36	76973	381603	2.19	17657	1136664	220598	14883	298038
1993-94	84.26	269.04	79352	394894	3.35	17832	1178194	232698	15401	306001
1994-95	n.a.	280.45	92692	414679	4.03	17989	1327340	259115	25315	320847

* Values for 1994-95 onwards based on projections described in text.

** Values are at 1989-90 prices.

Data Sources

I - Gross Fixed Capital Expenditure (Private plus Public) at 1989-90 prices from Data Express (DX) time series data service.

C - Consumption from the same source as I.

Y - Gross Domestic Product at 1989-90 prices from the same source as I.

K - Net capital stock from Data Express time series data and from Foster, R.A. and Stewart, S.E. (1991), "Australian Economic Statistics: 1949-50 to 1989-90", Reserve Bank of Australia, Sydney.

D - Net foreign liabilities from Foster and Stewart (1991) and ABS Catalogues 5306.0 and 5305.0

CAD - Current Account Deficit from ABS Catalogues 5302.0 and 5203.0

L - Aggregate Weekly Hours Worked by All Employed Persons from The Labour Force ABS Catalogue Nos.6203.0 and 6204.0, various issues.

r - Social Opportunity Cost of Consumption, as calculated in McDonald, Tacconi and Kaur (1991).

N - Total Population from Australian Demographic Statistics ABS Catalogue No.3101.0 and Projections of the Population of Australia ABS Catalogue No.3204.0.

IPD - Implicit price deflators for GDP, gross fixed capital expenditure and consumption from DX time series data service.

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CHART 1 The real rate of interest

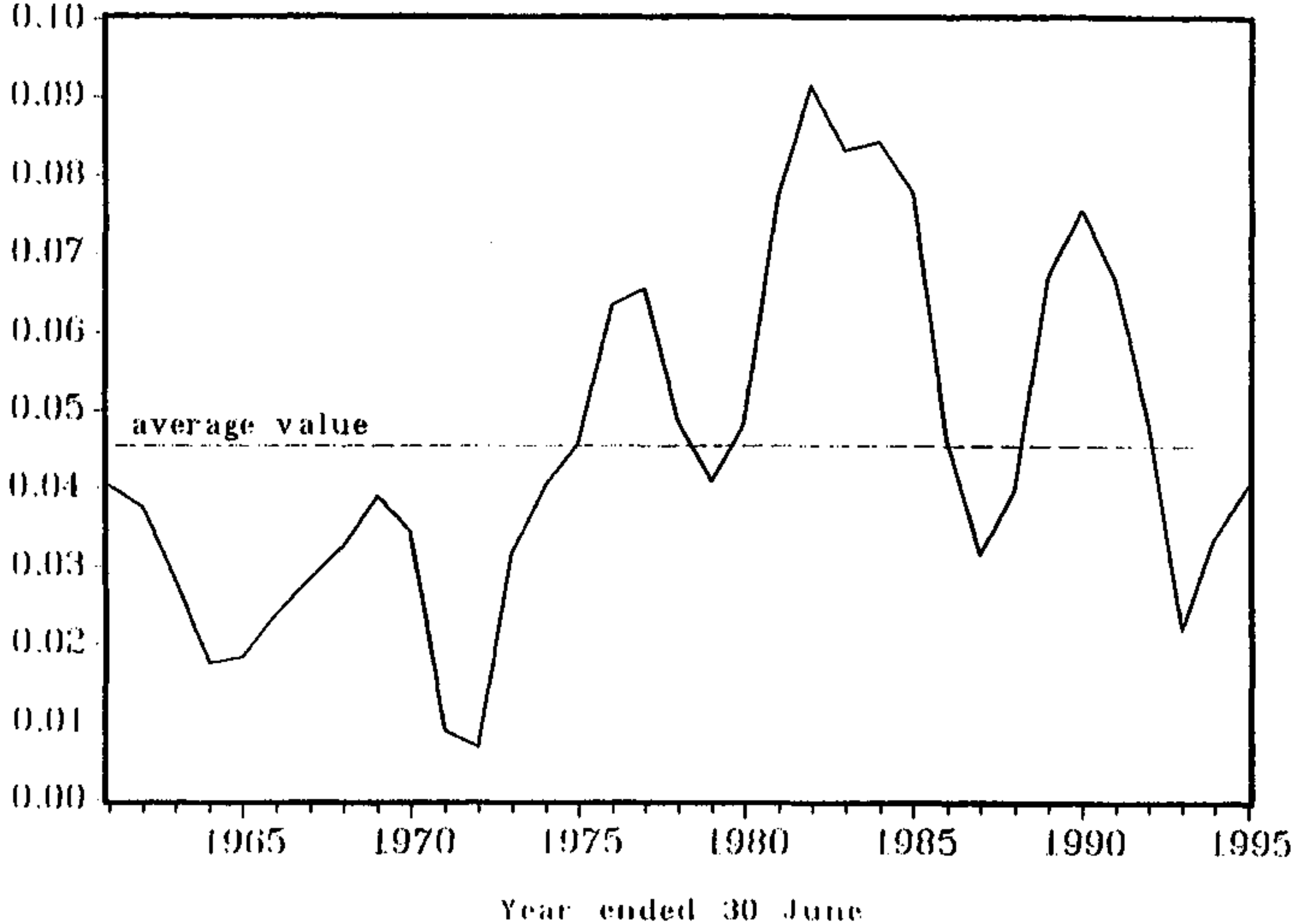

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CHART 2 Efficiency parameter

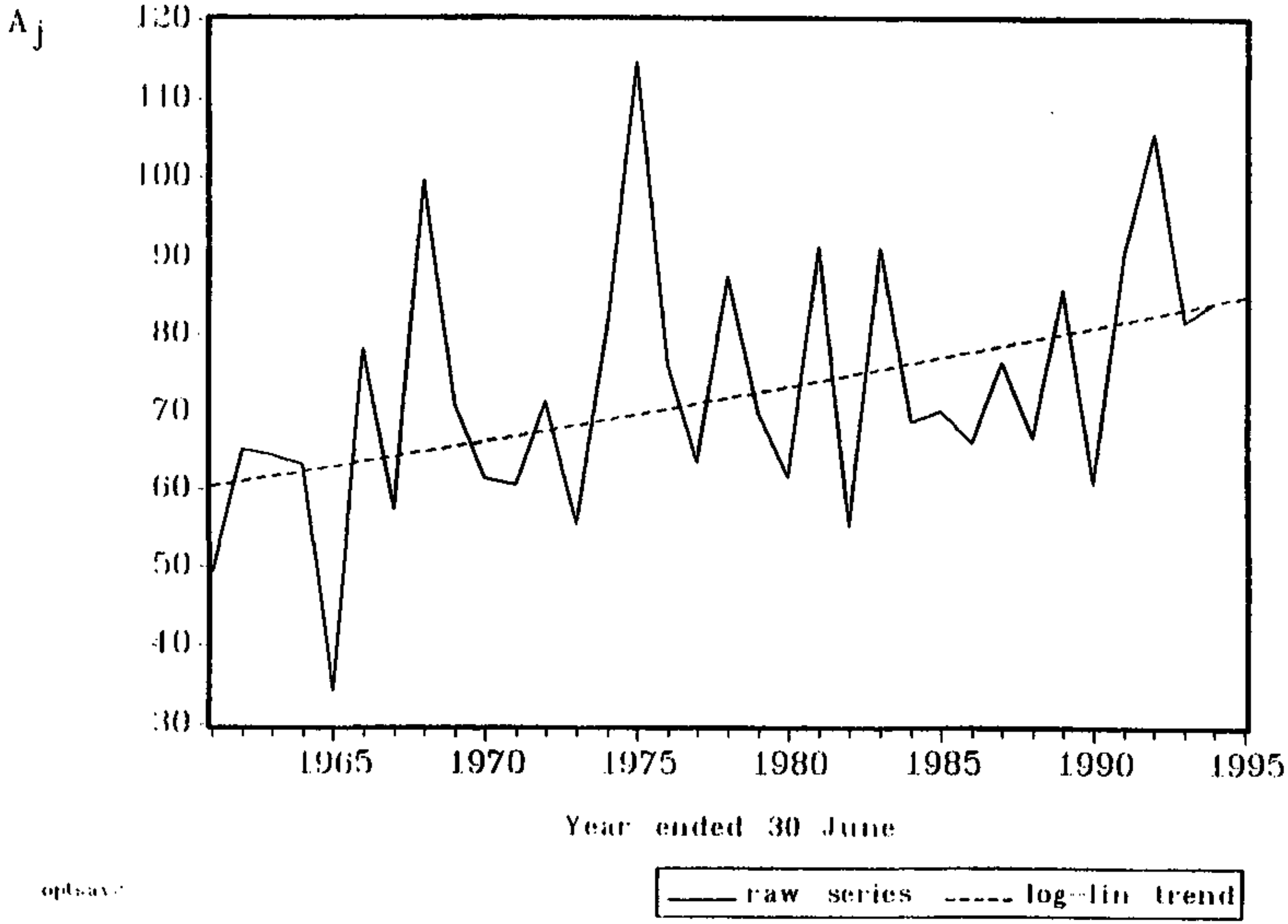

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CHART 3 Sensitivity of optimal CAD to the planning horizon

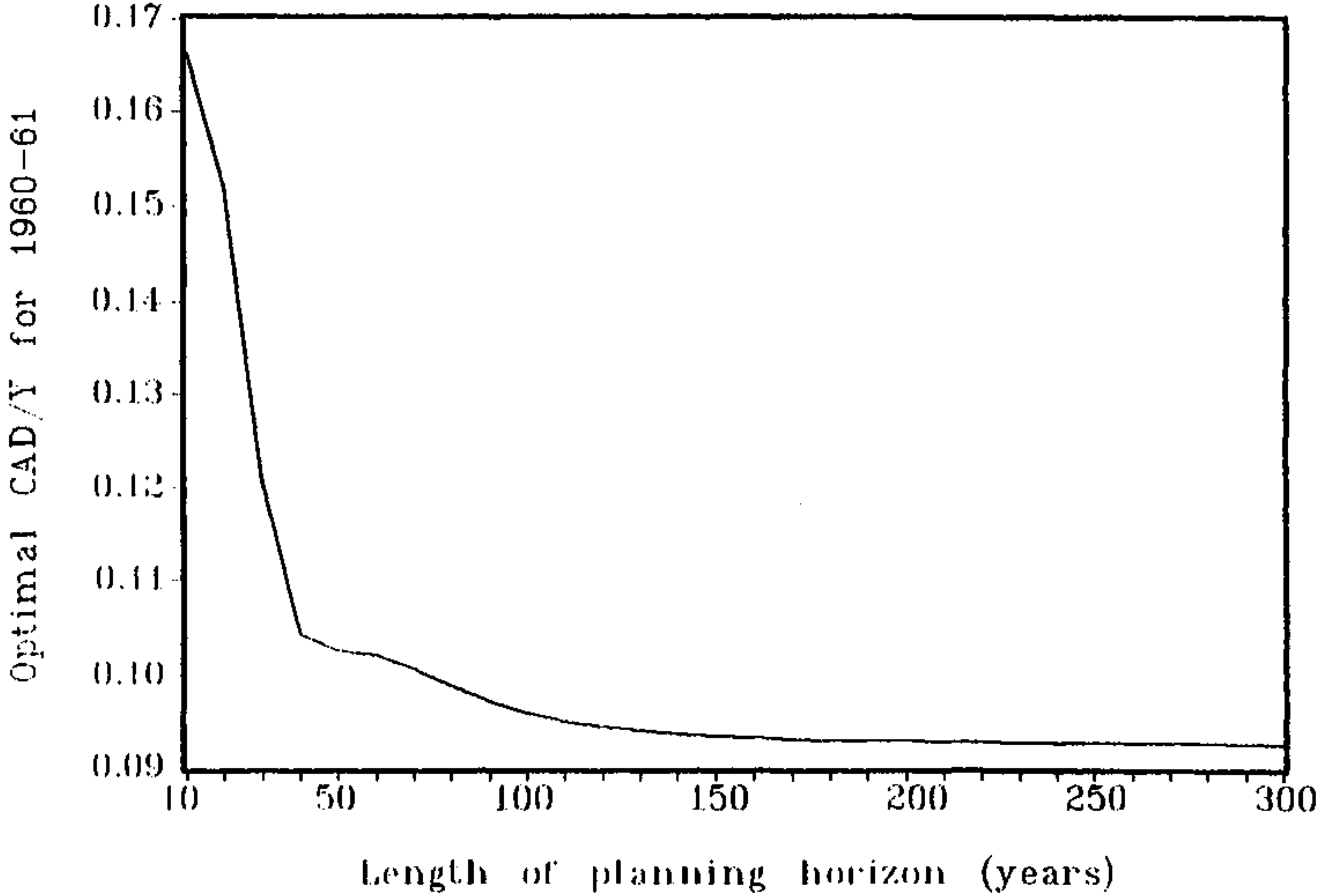

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CHART 4 The consumption balance for Australia: 1960–61 to 1994–95

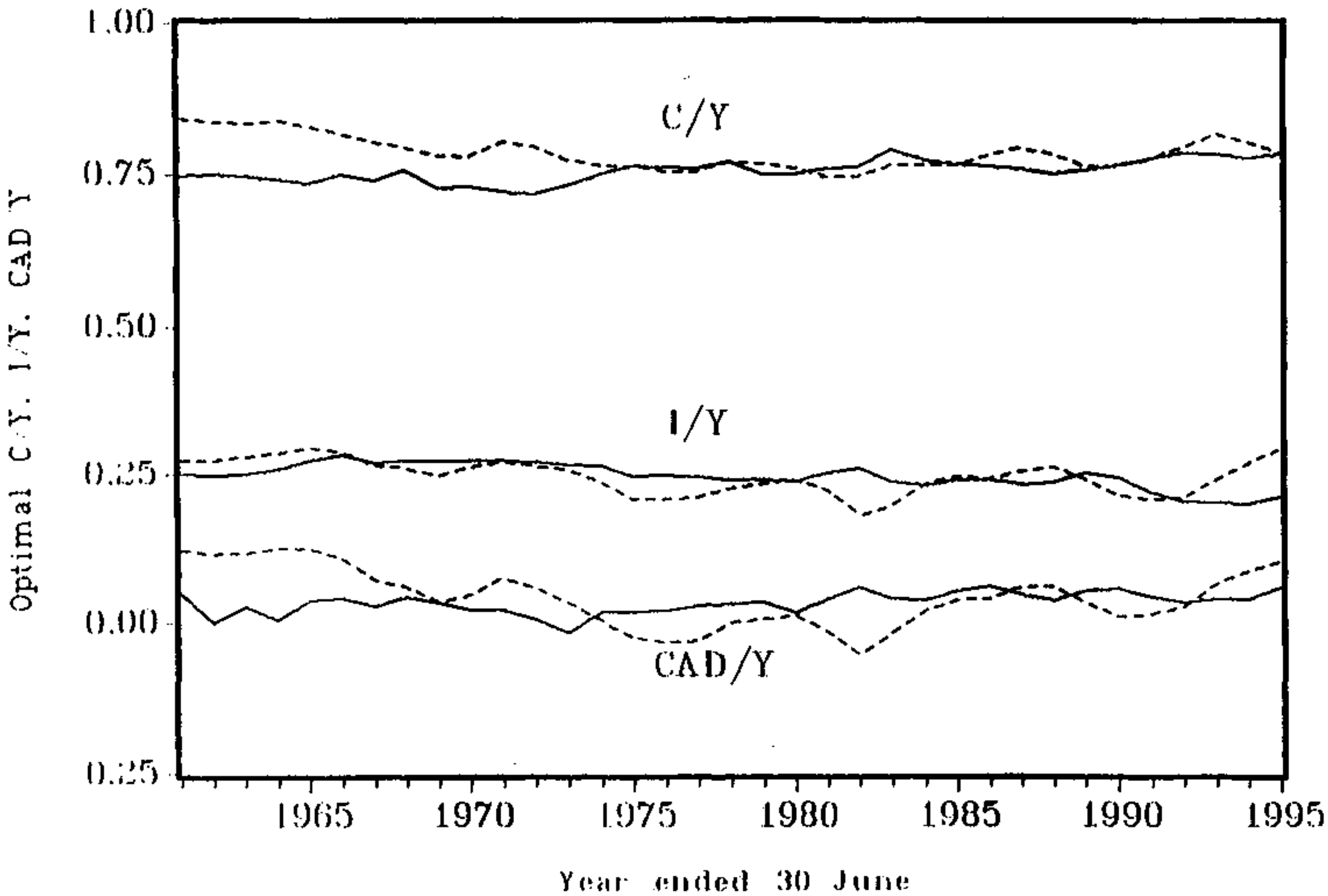

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CHART 5 Optimal saving for Australia for the period 1961 to 2050

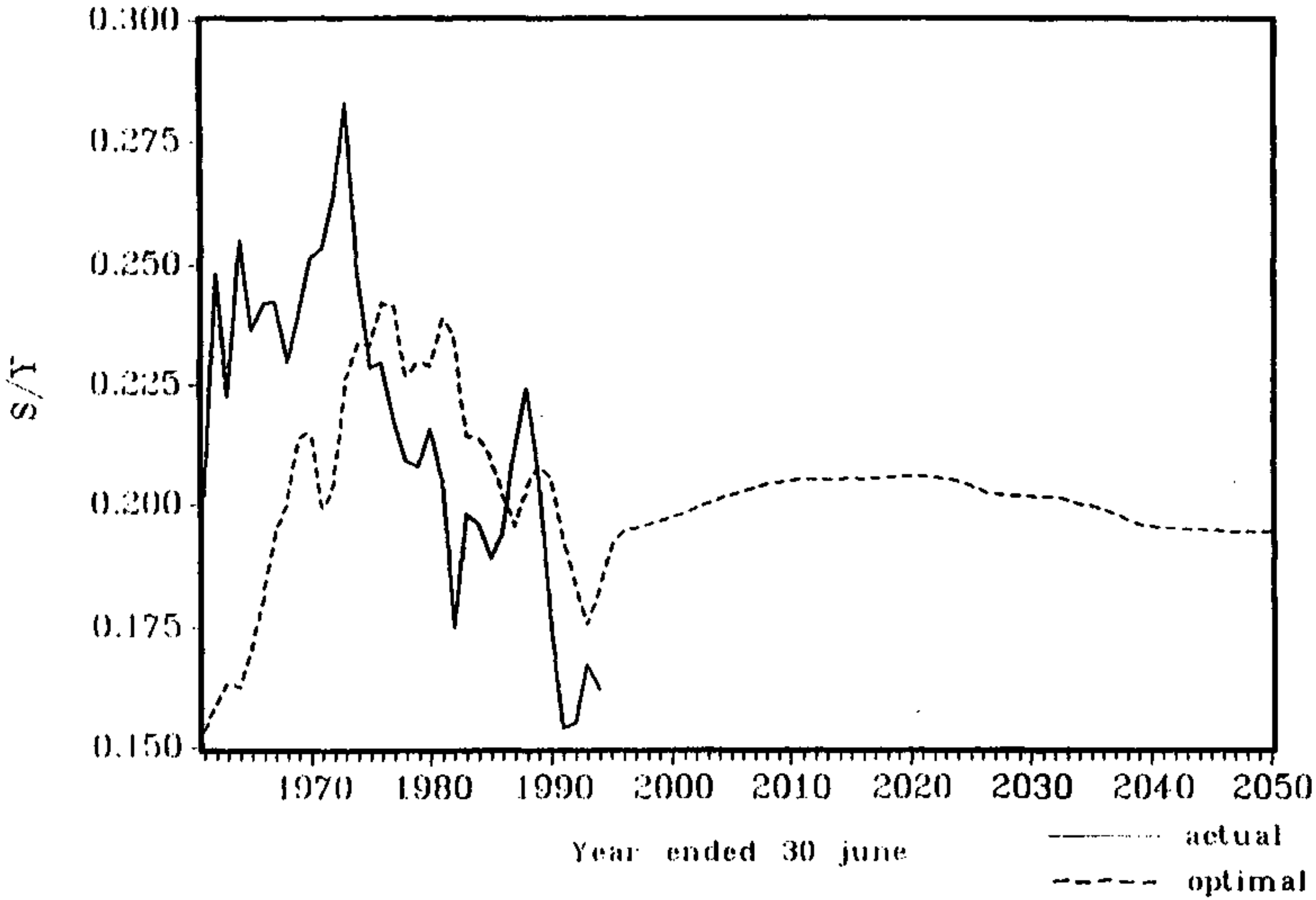

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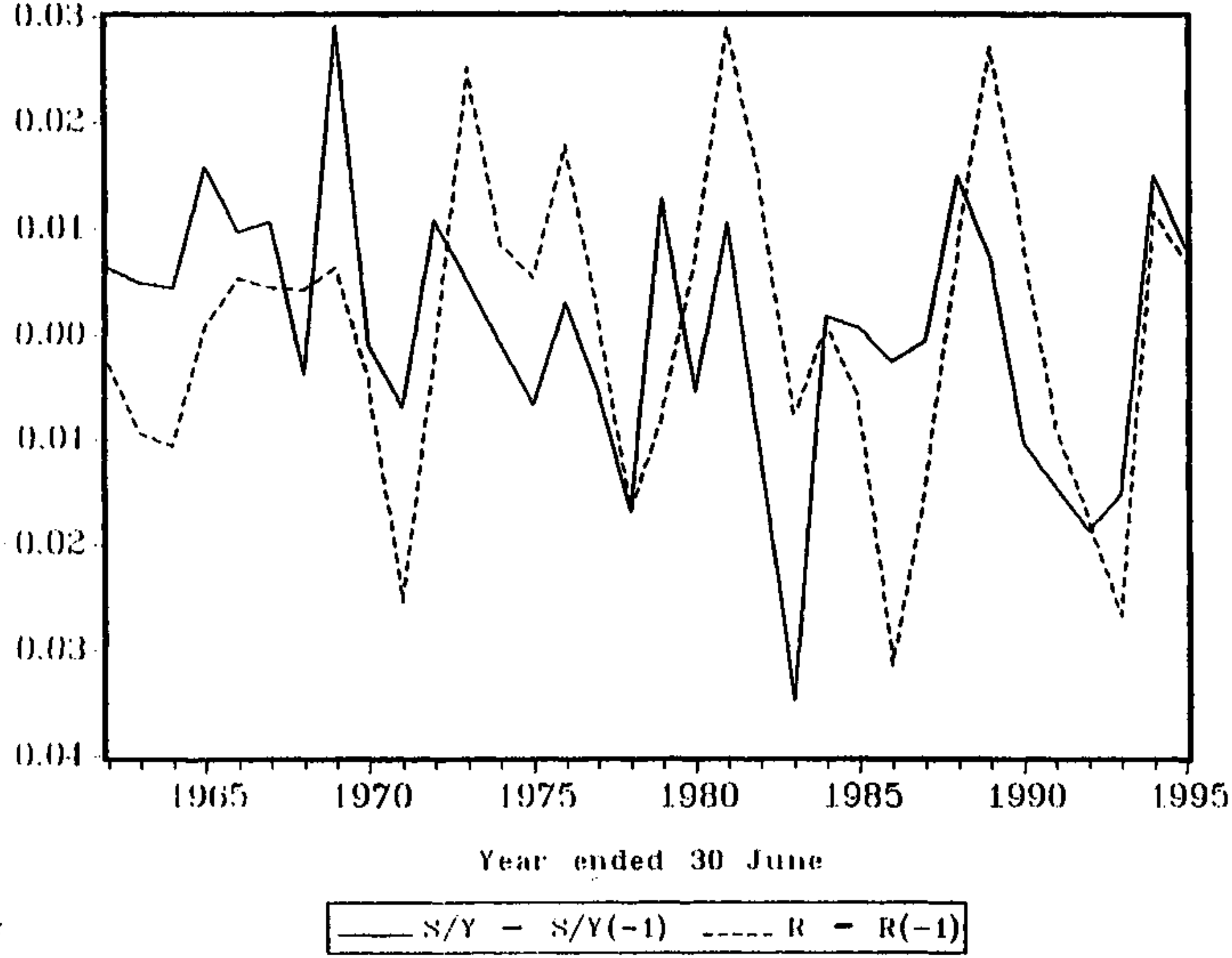
CHART 6 Deviations in the interest rate and deviations in saving



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