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WAGE-EARNERS' INVESTMENT FUNDS:
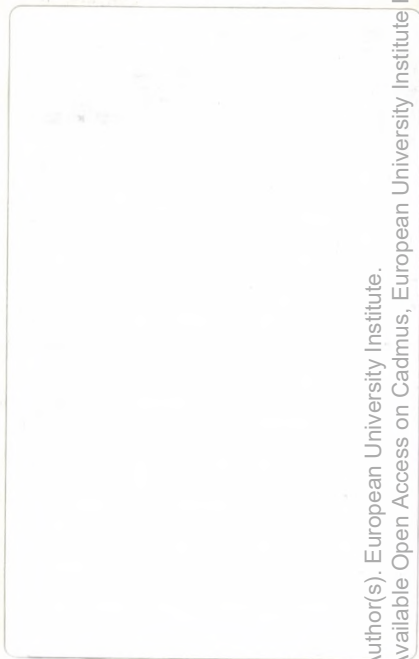**THEORY, SIMULATION AND POLICY**

by

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This paper was prepared while the author was visiting the European University Institute, to work on the project "The Effects of Workers' Participation Schemes in Western Europe".

BADIA FIESOLANA, SAN DOMENICO (FI)

1. Introduction

A wage-earners' investment fund is a form of collective ownership of capital which raises income from taxation and uses it to acquire shares on behalf of wage-earners. Such funds have been discussed in Western Europe during the 1970's and 1980's (Denmark (1973, 1979), West Germany (1974), Holland (1976), Sweden (1974, 1983), United Kingdom (1974)). The Swedish 1983 plan was implemented in December 1983.

For a discussion of the various institutional arrange-ments see George (1985b). The theory of such funds is discussed in George (1985a), Brems (1975a,b,c) and Kristofferson (1981) while Meidner (1978) provides an excellent account of the Swedish debate up to 1975.

Discussions of wage-earners' investment funds have normally been stimulated by the problems of ensuring efficient capital accumulation in highly unionised economies operating near full-employment. In such an economy wage-pressure can damage profitability and hence accumulation,or can be inflationary,or both. Deflationary policies are highly costly in terms of lost output and "union-busting" policies are likely to be unworkable in practice and unacceptable in principle. Unions may perceive the need for wage-restraint but argue that the benefits of such restraint should accrue, at least partially to them and not solely to owners of capital. Wage-earners' investment funds provide a means by which union wage-restraint can generate an increased measure of worker

influence over the accumulation process, as a quid pro quo for that restraint.

Such influence may well lead to increasing worker influence on the production process itself. This could take the form of codetermination within otherwise conventional firms or of the direction of resources towards participatory firms such as workers' cooperatives. It is a theme of the literature that accumulation in self-managed firms should be externally financed (see e.g. Vanek (1975)) and successful self-managed systems, such as the Mondragon cooperatives in Spain, typically do have an external funding agency. (In Mondragon it is a bank, the Caja Laboral Popular.) For a discussion of the relevance of wage-earners' funds to British economic policy see George (1985b).

Wage-earners' investment funds then provide a form of collective capital ownership in addition to orthodox nationalisation. Such a fund may provide a means to extend and develop a 'self-managed' sector within the economy and to promote worker-participation within conventional enterprises.

The kind of fund analysed in this paper is the kind described in the Danish 1973 proposal (Danish Government (1973)). This proposal formed the basis of the scheme suggested for the U.K. in the Labour Party's report "Capital and Equality" published in 1974 (Labour Party (1974)). Under the Danish 1973 proposal, the fund contributions are derived from a tax on the wage

bill.   It is levied at a rate $\alpha(t)$ (the contribution
fraction) in year t, with $\alpha(t)$ rising linearly in the first
$\bar{T}$ years of the fund's life and thereafter remaining
constant.   Individuals would hold non-negotiable fund
certificates which could be redeemed after a minimum
period of T years (the redemption period) at their fully
accumulated value.   In the Danish 1973 proposal the
contribution fraction rose by $\frac{1}{2}$% per year to reach a
maximum of 5% after ten years, thereafter remaining
constant.   The redemption period was seven years.   Of
course wage-earners' would be free to continue holding
their certificates beyond the redemption period and
continue earning the going rate of return.   Throughout
this paper however, it will be assumed that all redemptions
are made as soon as possible.

How successful a wage-earners' investment fund will be
in achieving its policy objectives will depend, inter alia,
on how much of the capital stock it owns.   This paper
provides an analysis of this question based on simulation
methods.   It also analyses the effects of varying the
two key policy parameters, α (the contribution fraction)
and T (the redemption period).

2:    A Simple Growth Model

The underlying theory of this paper is based on
George (1985a).   It involves a simple Pasinetti-type
model (Pasinetti 1962, 1974) of capital accumulation and
growth.   The model reflects a world in which adequate
investment is undertaken to fully employ a labour force

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growing exogenously at a constant-exponential rate (g).
Any technical progress is Harrod-neutral and can
therefore be subsumed in growth of the labour force.
The capital stock (K) is owned either by business
corporations (K_c) or by the fund (K_f).   Although workers
are assumed to save a small proportion of their incomes, this
saving is treated as attracting a zero real rate of return.
This reflects a situation in which workers' <u>individual</u>
savings are made in forms which do not attract a rate of
return above the rate of inflation.   During the late
1970's, for example, many British building society
deposits earned a <u>negative</u> real rate of return.   The
idea of a wage-earners' investment fund has been
supported by arguments which turn on a kind of "economy of
scale" in savings.   Arrangements for workers' <u>collective</u>
saving should generate a higher real rate of return
than workers could secure individually.   Throughout the
paper the fund is assumed to make the same real rate of
return on its capital as corporations do on theirs.
Workers are assumed to make a- zero real rate of return
on their savings which are assumed to lead to the
augmenting of corporations' capital (K_c).

No consumption occurs out of business income and,
following Pasinetti, the distribution of income is
assumed to adjust so as to ensure macroeconomic equilibrium.
The capital stock is assumed to depreciate at a constant
rate (δ).

National income (Y) either takes the form of wages (W)

or profits (P):

$$Y = W + P = wL + rK \tag{1}$$

(w = real wage rate, r = real profit rate)

Technology is of the fixed proportions variety:

$$Y = \min \ (aK, \ bL) \tag{2}$$

In the Pasinetti-world described above, labour, capital and output all grow at the exponential rate g and the capital labour ratio therefore remains constant:

$$K/L = b/a \equiv \rho \tag{3}$$

Equations (1), (2) and (3) imply:

$$aK = wL + rK$$
$$\Rightarrow \ w = (a-r) \ \rho \tag{4}$$

Equation (4) is a factor price frontier and macroeconomic equilibrium is ensured by movements along this frontier. Clearly:

$$0 \leq w \leq b \ , \ \ 0 \leq r \leq a \tag{5}$$

It will be assumed that workers have a constant average propensity to consume (c_w) which is the same for wage as for redemption income. It can easily be seen that this assumption will ensure that the workers' share in national income is unaffected by the presence of the fund. Let Y_w, Y_f and Y_c be the incomes of workers, the fund and corporations respectively.

(Income shares will be denoted in lower case letters:

$$y_w \equiv Y_w/Y, \quad y_f \equiv Y_f/Y, \quad y_c \equiv Y_c/Y).$$

Then macroeconomic equilibrium requires that investment equals savings:

$$(g + \delta)K = Y - c_w Y_w \qquad (6)$$

$$\Rightarrow (g + \delta)K = aK - c_w Y_w$$

$$\Rightarrow y_w = \frac{a - g - \delta}{ac_w} \qquad (7)$$

Thus the workers' share in national income is determined by parameters independent of the central fund. Moreover it is clear from equation (7) that, for viability, we require:

$$a \geq g + \delta \qquad (8)$$

In most proposals actually advanced the contribution fraction (α) would increase linearly over the first few $(\bar{T})$ years of the fund's life to a maximum (α^*). It will be assumed throughout this paper that <u>all</u> redemptions occur after the (minimum) redemption period of T years. Thus it is not until time $T + \bar{T}$ that contributions and redemptions are based on the same fraction (see fig. 1). Throughout this paper, periods in excess of $T + \bar{T}$ will be referred to as the "long-run". (Note that in the Danish 1973 proposal $\bar{T} = 10$, $\alpha^* = 5\%$, $T = 7$).

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Fig. 1 near here

3: Equilibrium Paths

An equilibrium path is one along which the factor
price frontier equation (equation (4)) and the macroeconomic
equilibrium condition (equation (6)) are simultaneously
satisfied.   With a fund operating in the economy,
equation (6) becomes

$$(g + \delta)K = Y - c_w(W + R - B) \tag{9}$$

(where R = redemption income B = fund contributions).
Let $\alpha(t)$ = contribution fraction, then on the
assumptions of section 2, equation (9) gives:

$$(g + \delta)K(t) = Y(t) - c_w(1 - \alpha(t))w(t) L(t) + R(t)) \tag{10}$$

The problem then is to derive an expression for $R(t)$.
Obviously for $t < T$, $R(t) = 0$.   On the assumptions of
section 2 (for $t \geq T$) $R(t)$ is the contribution made to
the fund at time $t-T$, fully accumulated at the going rate
of profit, defined net of the rate of depreciation.
That is to say, for $t \geq T$,

$$R(t) = \alpha(t-T) \, w(t-T) \, L(t-T) \, e^{-\delta T} \, e^{A(t)} \tag{11}$$

$$\text{where} \quad A(t) = \int_{t-T}^{t} r(s) ds \tag{12}$$

Equation (11) gives

$$R(t) = \alpha(t-T) \, w(t-T) \, L(t) \, e^{-(g+\delta)T} \, e^{A(t)} \tag{13}$$

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since the labour force is growing exponentially at a
rate g.   Using the factor price frontier (4) and
substituting (13) into (10) we obtain:

$$(g + \delta)K(t) = Y(t) - c_w((1-\alpha(t))(a-r(t))\rho L(t) + \alpha(t-T)(a-r(t-T))\rho L(t) e^{-(g+\delta)T} e^{A(t)}) \qquad (14)$$

Dividing through by L(t) and using the production function
(equation (2)), this gives:

$$(g + \delta) = a - c_w((a-r(t))(1-\alpha(t)) + \alpha(t-T)(a-r(t-T)) e^{-(g+\delta)T} e^{A(t)}) \qquad (15)$$

Equation (15) gives a general equation for solution paths
in r(t) (and hence in w(t), via the factor price frontier).
Unfortunately, it is impossible to solve because of the
presence of the term in $e^{A(t)}$ on the R.H.S.   It is possible
however to establish a sufficient condition under which a
constant price path exists in the long run.
In the long run $(t \geq T + \bar{T})$ contribution and redemption
fractions are equal and constant over time:

$$\alpha(t) = \alpha(t-T) = \alpha \quad \text{for all } t \geq T + \bar{T} \qquad (16)$$

A constant price path is one along which both wage rate and
profit rate are constant over time:

$$r(t) = r, w(t) = w = (a-r)\rho \text{ for all } t \geq T + \bar{T} \quad (17)$$

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Substituting (16) and (17) into the general expression (15) we obtain:

$$g+\delta = a-(a-r) \; c_w \; (1-\alpha + \alpha \, e^{(r-\delta-g)T}) \qquad (18)$$

To find sufficient conditions for (18) to have a solution, define $\emptyset(r)$ by:

$$\emptyset(r) = g+\delta - a + (a-r) \; c_w \; (1-\alpha + \alpha \, e^{(r-\delta-g)T} \qquad (19)$$

Clearly $\emptyset$ is continuous in r and moreover:

$$\emptyset(a) = g + \delta - a < 0 \qquad (20)$$

from (8). Note also that $0 \leq r \leq a$, from (5).

Then if $\emptyset(0) > 0$, the equation $\emptyset(r) = 0$ must have a solution $(0 \leq r \leq a)$. We have from (19):

$$\emptyset(0) = g + \delta - a + a c_w \; (1 - \alpha + \alpha \, e^{-(\delta+g)T}) \qquad (21)$$

Thus a <u>sufficient</u> condition for $\emptyset(0) > 0$ and hence for the existence of a constant price path is

$$g + \delta + (c_w \; (1 - \alpha) - 1)a > 0 \qquad (22)$$

Various long run properties of constant price paths are discussed in George (1985a) and will not be duplicated here[2]. A major purpose of the present paper is to deal with the <u>short run</u> $(t \leq T + \bar{T})$ when both contribution and redemption fractions are varying (see figure 1). In this case, in

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general, constant price paths do not exist and recourse
must be made to simulation methods in order to deal with the
equilibrium condition (equation (15)). These methods and
the simulation results are described in the following
sections. The simulated paths exhibit, in the long run,
heavily damped oscillations around the corresponding constant
price paths defined by equation (18). All the qualitative
results of George (1985a), which relate to constant price
paths, re-appear for the simulated paths.

4: Simulation

Simulations were carried out using a very simple
Fortran programme. First the model must be re-expressed
in discrete time form. Let:

$R(t)$ = redemption income paid at the <u>beginning</u> of year t

$K_f(t)$ = fund capital at beginning of year t <u>net</u> of $R(t)$

Hence:

$R(t)$ = O $t \leq T$

$R(t)$ = $(1+r(t-1)-\delta)$ $(1+r(t-2)-\delta)...(1+r(t-T)-\delta)$
$\alpha(t-T)w(t-T)L(t-T)$ $t > T$ (23)

For each time period the programme solves for
equilibrium $w(t)$ using an equation similar to (9) and then
calculates $r(t)$ from the factor price frontier
(equation (4)). It then calculates redemption payments
for the next time period $(R(t+1))$ from which it can obtain
the income of the fund in year t. At each stage the
fund's share in the capital stock $(K_f(t)/K(t))$ is printed
out along with the wage and profit rates and the

contribution fraction.   Using the fund's income in period
t, the programme calculates $(K_f(t+1)$, increases K, L and Y
by the exogenous growth rate (g) and then repeats the whole
process over again.   This continues for 99 periods.   The
contribution function rises by an amount $\bar{\alpha}$ for each of
the first $\bar{T}$ years and then remains constant at $\bar{\alpha}.\bar{T}$.   The
structure of the programme is set out in Figure 2.

Figure 2 near here.

Some of the parameter values were kept constant for
all the simulation runs.   They were:

$$g \quad = \quad 3\%$$
$$c_w \quad = \quad 0.95$$
$$a \quad = \quad 0.3$$
$$b \quad = \quad 50.0$$
$$\bar{T} \quad = \quad 10$$

The other parameters were varied between runs as follows:

$$T \quad = \quad 7, 10, 15$$
$$\bar{\alpha} \quad = \quad 0.5\%, 1.0\% \text{ (giving maximum} $$
contribution fractions
of 5% and 10%)
$$\delta \quad = \quad 2\%, 4\%$$

Thus twelve runs are reported altogether all of which
satisfy the sufficient condition (equation (22)) for the
existence of a constant price path in the long run.   Note that

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T = 7, $\bar{\alpha}$ = 0.5% corresponds to the Danish 1973 proposal.
The results of this run (for δ = 2%) are depicted in
figure 3 and, qualitatively, are typical of all the runs.
The fund's share in the capital stock peaks at or just after
time T + $\bar{T}$ and then declines gradually to its long run
value. The profit rate falls to a minimum at time $\bar{T}$,
then rises and exhibits heavily damped oscillates about its
long run value. The (pre-tax) wage rate is simply

Fig. 3 near here

determined via the factor price frontier and consequently
always moves in the opposite direction to the profit
rate.The (pre-tax) wage rate rises in the first $\bar{T}$ years
as the contribution tax rate rises, showing that the burden
of this tax is initially shifted to profits, though by
time T + $\bar{T}$ the burden is shifted back to wages. The workers'
share in income of course remains constant with changes in
(after-tax) wage income being matched by opposite changes in
redemption income.

Tables 1 and 2 show maxima, minima, and long-run
values for four key economic variables, the contribution
fraction (α), the fund's share in the total capital stock
(k_f) the profit rate (r) and the wage rate (w). The runs
in table 1 have δ = 2% while those of table 2 have δ = 4%.
It is clear that high depreciation rates effect the fund
adversely, slightly lowering its share in the capital stock
(cet. par.). Both tables depict substantially lower fund

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shares than were suggested in Danish Government calculations
(Danish Government 1973).   These suggest that after eight
years the fund's share would be 10% and after 15 years,
35%.   The first runs in tables 1 and 2 correspond to the
parameter values of the Danish 1973 proposal.   They
indicate maximum fund-shares of 7.48% and 6.89% respectively
and long run fund shares of 6.53% and 5.91% respectively.

Tables 1, 2 near here

It is clear from both tables that raising the
contribution fraction and lengthening the redemption period
increases the fund-share, both maximum and long-run.   This
is consistent with the analysis of constant price paths
in George (1985a).   A redemption period of 15 years and a
maximum contribution fraction of 10% gives values of k_F
closer to Danish official estimates.   In this case k_F reaches
7.12% after eight years and 22.21% after ten years;   it
peaks at 32.64% after 34 years and declines to a long-run
value of 31.77%

5:    Conclusion

The impact of a wage-earners' investment fund on the
economy will depend crucially on how large a share of the
capital stock it controls.   The results of the simulation
analysis reported here suggest fund-shares substantially
lower than those indicated in official estimates.   The
fund shares can be increased by lengthening the redemption
period or raising the contribution fraction.   Both measures,

particularly the latter, would sharply reduce the real
profit rate in the short run, which may present problems
of its own.   Increasing the redemption period would
possibly be resisted by the trade unions.   In Denmark
they originally wanted a five year rather than a seven
year redemption period,   though the present Swedish
arrangements allow redemptions only in the form of
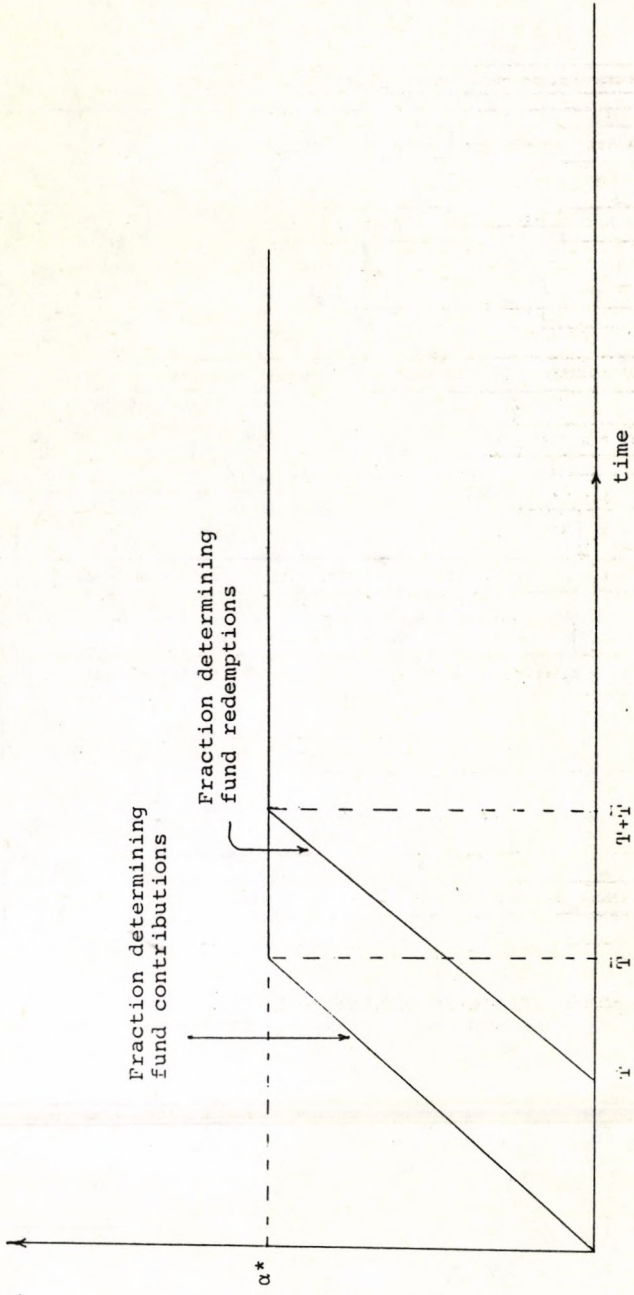pensions.

The possibility of the fund taking over the entire
capital stock is a remote one.   Indeed, governments would
have to contemplate substantially higher contribution
fractions and longer redemption periods than has hitherto
been the case if a wage-earners' investment fund is to
achieve a share in the capital stock substantially greater
than that of a medium-sized private pension fund.

FOOTNOTES

1. An earlier version of this paper was given
    at seminars at L.S.E. and the European
    University Institute, Florence, Italy.
    I am grateful for the constructive comments
    made at those seminars.
    I would particularly acknowledge the helpful
    advice and comments of Saul Estrin, Stanislaw
    Gomulka, Mario Nuti and Will Bartlett.   The
    usual disclaimer applies.

2. In interpreting results from George (1985a)
    in terms of the present paper, the natural
    growth rate n in the former paper must be
    replaced by the growth rate gross of
    depreciation, $g + \delta$.

Figure 1
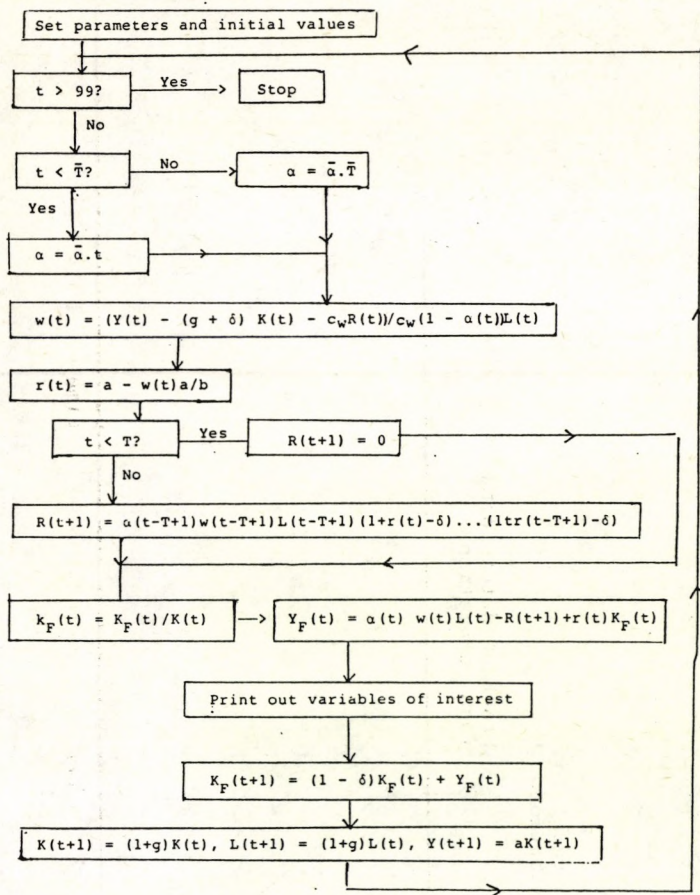
Fig.2: Flow Diagram for the Simulation Progamme

Set parameters and initial values

t > 99? — Yes → Stop

No

t < $\bar{T}$? — No → $\alpha = \bar{\alpha}.\bar{T}$

Yes

$\alpha = \bar{\alpha}.t$

$w(t) = (Y(t) - (g + \delta) K(t) - c_w R(t))/c_w(1 - \alpha(t))L(t)$

$r(t) = a - w(t)a/b$

t < T? — Yes → $R(t+1) = 0$

No

$R(t+1) = \alpha(t-T+1)w(t-T+1)L(t-T+1)(1+r(t)-\delta)...(1tr(t-T+1)-\delta)$

$k_F(t) = K_F(t)/K(t)$ → $Y_F(t) = \alpha(t) w(t)L(t)-R(t+1)+r(t)K_F(t)$

Print out variables of interest

$K_F(t+1) = (1 - \delta)K_F(t) + Y_F(t)$

$K(t+1) = (1+g)K(t)$, $L(t+1) = (1+g)L(t)$, $Y(t+1) = aK(t+1)$

Figure 3   Simulation Run for the Danish (1973) proposal

($T = 7$, $\bar{\alpha} = 0.5\%$, $\delta = 2\%$)
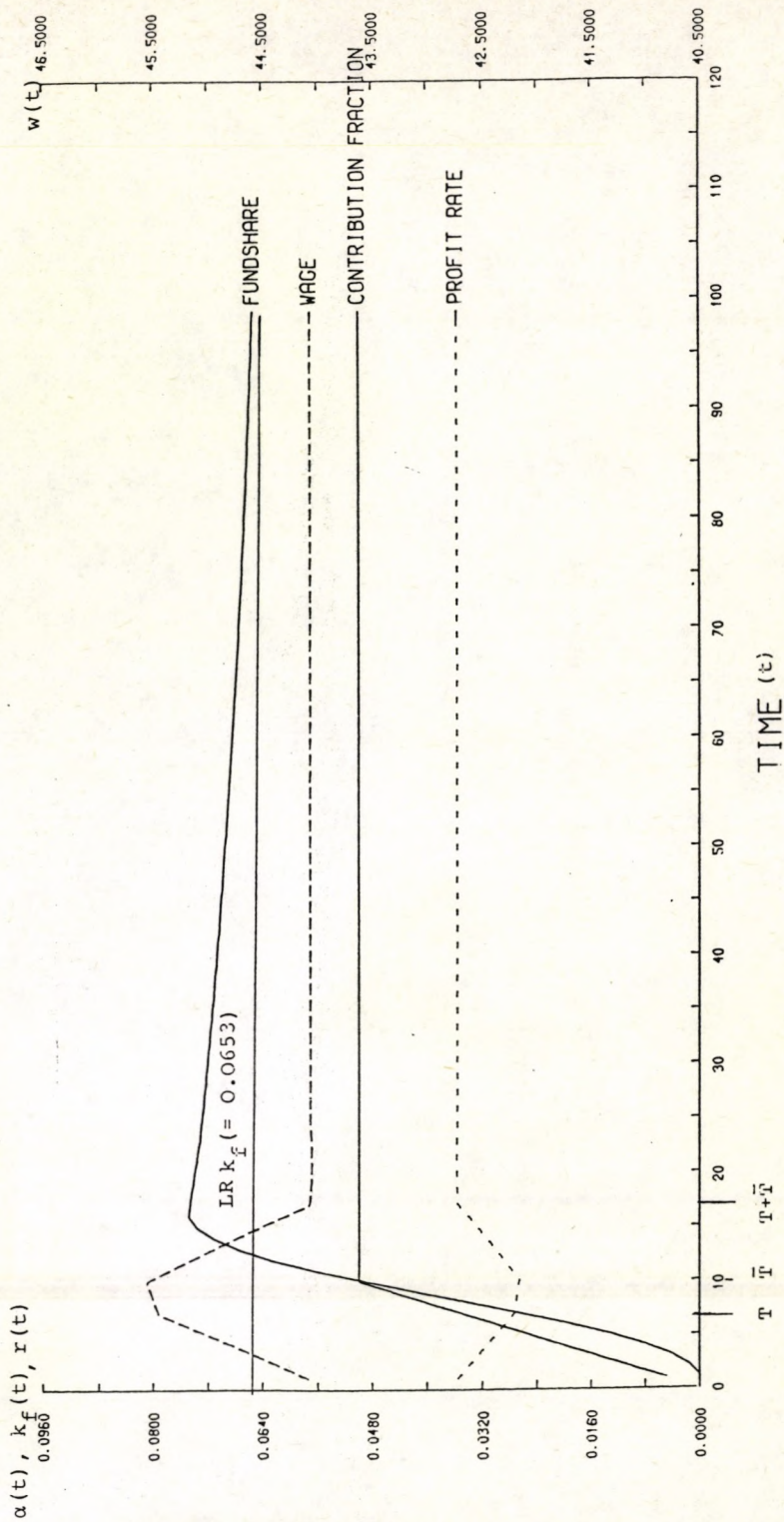
		$\alpha(\%)$	k_f (%)	r (%)	w
T = 7, $\bar{\alpha}$ = 0.5% δ = 2%	Max	5	7.48	3.56	45.56
	Min	O	0.0	2.66	44.07
	LR	5	6.53	3.56	44.07
T = 7, $\bar{\alpha}$ = 1.0% δ = 2%	Max	10	15.25	3.42	47.50
	Min	O	0.0	1.50	44.30
	LR	10	13.41	3.41	44.32
T = 10, $\bar{\alpha}$ = 0.5% δ = 2%	Max	5	10.96	3.55	46.17
	Min	O	0.0	2.30	44.08
	LR	5	10.14	3.50	44.16
T = 10, $\bar{\alpha}$ = 1.0% δ = 2%	Max	10	22.20	3.42	48.73
	Min	O	0.0	0.76	44.30
	LR	10	20.70	3.27	44.56
T = 15, $\bar{\alpha}$ = 0.5% δ = 2%	Max	5	16.35	3.55	46.17
	Min	O	0.0	2.30	44.08
	LR	5	15.75	3.41	44.32
T = 15, $\bar{\alpha}$ = 1.0% δ = 2%	Max	10	32.64	3.42	48.73
	Min	O	0.0	0.76	44.30
	LR	10	31.77	2.99	45.01

Table 1: Summary of simulation runs for δ = 2%

		$\alpha\,(\%)$	$k_f\,(\%)$	$r\,(\%)$	w
$T = 7,\ \bar{\bar{\alpha}} = 0.5\%$ $\delta = 4\%$	Max	5	6.89	5.68	41.91
	Min	0	0.0	4.86	40.53
	LR	5	5.91	5.68	40.53
$T = 7,\ \bar{\alpha} = 1.0\%$ $\delta = 4\%$	Max	10	14.07	5.56	43.68
	Min	0	0.0	3.79	40.73
	LR	10	12.12	5.56	40.75
$T = 10,\ \bar{\alpha} = 0.5\%$ $\delta = 4\%$	Max	5	10.14	5.67	42.47
	Min	0	0.0	4.52	40.55
	LR	5	9.26	5.64	40.60
$T = 10,\ \bar{\alpha} = 1.0\%$ $\delta = 4\%$	Max	10	20.54	5.54	44.83
	Min	0	0.0	3.10	40.76
	LR	10	18.90	5.44	40.93
$T = 15,\ \bar{\alpha} = 0.5\%$ $\delta = 4\%$	Max	5	15.17	5.67	42.47
	Min	0	0.0	4.52	40.55
	LR	5	14.51	5.56	40.74
$T = 15,\ \bar{\alpha} = 1.0\%$ $\delta = 4\%$	Max	10	30.37	5.54	44.83
	Min	0	0.0	3.10	40.76
	LR	10	29.32	5.22	41.30

Table 2: Summary of simultation runs for $\delta = 4\%$

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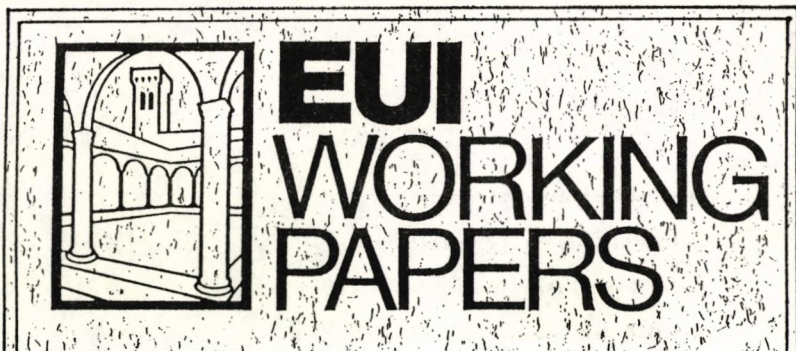
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