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APPRAISING THE PROFITABILITY AND FEASIBILITY OF AN AGRICULTURAL INVESTMENT UNDER INFLATION

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SUMMARY

The purpose of this report is to examine the efficacy of conventional investment appraisal techniques under inflationary conditions and to suggest modifications to circumvent the shortcomings highlighted. As the rate of inflation and interest rates tend to move in unison, discounting the net cash flows generated by an investment at the nominal rate of interest in a period of high inflation will impose a heavy burden on the project. Many projects that would be shown to be profitable at lower interest rates will appear to be unprofitable and may not be undertaken. This situation arises because no allowance is made for the fact that the payment of interest and repayment of capital will be made in devalued money.

The problem can be overcome by discounting the net cash flows at the real rate of interest, which is the nominal rate of interest adjusted for inflation. This gives a true appraisal of the profitability of the project. It does however have a serious drawback in that it gives no information on the feasibility of the project, that is, whether the cash returns will be sufficient to cover repayments of capital and interest charges.

A more appropriate approach is to inflate the net cash flows by the expected rate of inflation and then discount these net cash flows at the nominal rate of interest. This gives an identical assessment of the profitability of a project to using the real rate of interest but also indicates whether or not the project is feasible.

An inaccuracy in the calculation of the internal rate of return when allowance is made for taxation is identified and a solution proposed.

The impact of different marginal income tax rates on an investment is also briefly examined.

1. INTRODUCTION

The method of investment appraisal using discounted cash flows is well established.[1] Future net cash flows, calculated in terms of constant money values, are discounted to convert them to present values. The further into the future any given amount of net cash is received, and the higher the discount rate taken, the lower is its present value. This allows for the fact that money received now is worth more than money received in the future.

Thus, in simple terms, the present cost of an investment can be compared with the present value of a series of future net cash flows. If the latter is greater than the former the investment is held to be worthwhile, or profitable. The difference between these two figures is called the net present value. The internal rate of return, or discounted yield, can also be derived from this procedure. This is the discount rate at which the future net cash flows exactly equal the present expenditure, i.e. at which the net present value is zero. It is therefore the interest rate at which the project breaks even and it sets an upper limit to the interest rate that the project can pay and still remain profitable. All this assumes that the future net cash flows are accurately forecast.

Theoretically the discount rate that is chosen in order to calculate the net present value of a project should be the opportunity cost of investor's capital, that is, either the return from the best available alternative investment or the cost of borrowing the capital, whichever is the greater. This is known as the cost of capital. Since it is time-consuming and often difficult for many reasons to calculate the return from other possible investments on the farm, it is common practice to use the cost of borrowing capital as the cost of capital in investment appraisal.

In addition to calculating the expected profitability of an investment, the appraisal should also establish the maximum level of borrowing required to finance the project. Should this exceed the capital available then the project, even though it might be profitable, will be financially infeasible and should therefore be rejected.

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[1] It is assumed in this report that the reader is familiar with the discounted cash flow technique of investment appraisal. A description can be found in Barnard, C.S. and Nix, J.S., Farm Planning and Control, 2nd. edition (1979), Cambridge University Press (Chapter 3).

2. THE PROBLEM OF INFLATION

It is common practice for those carrying out investment appraisal, whether or not discounted cash flow procedures are used, to ignore the problem of inflation. One argument for this approach is that future levels of inflation are impossible to forecast accurately and should therefore be excluded. It is also argued that if both input and output prices rise at the same rate, the real value of the net cash flows will remain the same as in the absence of inflation. However, the net cash flows will obviously increase in monetary terms, which will result in a higher internal rate of return and a higher net present value at any given discount rate, or cost of capital.

(If the prices of inputs and outputs increase at varying rates, then the change in the net flow and therefore the net present value and internal rate of return will clearly depend on the combined effects of these price movements. However, if the rate of price increase of different inputs or outputs varied disproportionately, the farmer may adjust the proportions in which he uses his inputs, which may affect the outputs obtained, so as to improve the net effect).

A further problem implicit in the discounted cash flow technique of investment appraisal is generated by the convention of using the cost of borrowing as the discount rate. Inflation rates and interest rates tend to move in the same direction, i.e. as inflation increases so does the cost of borrowing (Table 1). If the latter is used to determine the discount rate, not only will the net present value be decreased if the cash flows are not adjusted for inflation but the true cost of servicing the investment will be overstated. In general, the higher the level of inflation, the more net present values are decreased and the greater the overstatement of servicing costs because of the probable concomitant increase in interest rates.

To summarise, the profitability of an investment is significantly affected by inflation, the results of which can be viewed in either of two ways:

a) the cost of financing the investment is reduced, since the interest and capital repayments are made in devalued money, or

b) the future earnings of the project increase in monetary terms.

Thus inflation will indirectly <u>reduce</u> the apparent wisdom of making an investment (if it is ignored in discounting procedures), whereas it is in fact more likely to <u>increase</u> the likelihood of an investment being profitable.

3. THE 'REAL' RATE OF INTEREST

In recognition of this problem it has been suggested that the future cash flows should be discounted at the real rate of interest rather than the nominal rate of interest (Crabtree, 1978). The real rate of interest is calculated by adjusting the nominal rate of interest to allow for inflation, as follows[1]:

$$R = [((1+i)/(1+f))-1]x100$$

where R = real rate of interest (expressed as a decimal)

i = nominal rate of interest (" " " ")

f = rate of inflation (" " " ")

Thus if, for example, the nominal rate of interest is 15 per cent and the rate of inflation is 13 per cent, the real rate of interest is as follows:

$$R = [((1.15)/(1.13))-1]x100 = 1.77$$

The real rate of interest is therefore 1.77 per cent.

Discounting at the real rate of interest allows for the repayment of debt with devalued money. As such it increases the apparent profitability of projects, since future cash flows have greater present values at lower discount rates. Table 1 shows the relationship between the real rate of interest and the nominal rate of interest. The real rate of interest has not risen above 5.4 per cent in the 30 years between 1950 and 1980 and has even been negative in several years. For simplicity, the effects of tax relief on the interest payments and therefore on the real rate of interest are ignored at this stage.

To illustrate the effects of this modification a capital investment project is appraised below, using both the nominal rate of interest and the real rate of interest.

The project is the purchase of some additional land costing £50,000. The farmer estimates that his additional profit will be £5,000 per year. He expects to resell the land for the same sum when he retires in ten years' time. The nominal interest rate is 15 per cent and the expected rate of inflation is 13 per cent per annum.

Discounting the cash flows at the nominal interest rate of 15 per cent generates a net present value of -£12,547 and the internal rate of return is 10 per cent (Table 2). The farmer would conclude that the project was not profitable.

In contrast, if the cash flow is discounted at the real rate of interest of 1.77 per cent, the project shows a net present value of £37,412 and the real (i.e.

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[1] An approximation to this can be obtained by subtracting the rate of inflation from the nominal rate of interest when both are expressed as percentages, e.g. in the above case, 15% - 13% = 2%.

TABLE 1. Average A.M.C. Mortgage Interest Rates, changes in the Retail Price Index and Real Rates of Interest, 1950-79.

Year	Average A.M.C. Mortgage Interest Rate (i)	Percentage Change In Retail Price Index (f)	Real Rate of Interest (R)
	%	%	%
1950	4.0	3.2	0.8
1951	4.2	9.1	-4.5
1952	5.5	9.1	-3.3
1953	5.6	3.0	2.5
1954	4.7	2.0	2.6
1955	4.9	4.4	0.5
1956	5.0	4.9	0.1
1957	6.0	3.7	2.2
1958	6.6	3.1	3.4
1959	5.7	0.5	5.2
1960	6.5	1.1	5.3
1961	6.9	3.4	3.4
1962	7.1	4.3	2.7
1963	6.0	1.9	4.0
1964	6.6	3.2	3.3
1965	7.5	4.8	2.6
1966	8.1	3.9	4.0
1967	8.0	2.5	3.4
1968	8.4	4.7	3.5
1969	9.8	5.4	4.2
1970	9.9	6.4	3.3
1971	10.1	9.4	0.6
1972	9.0	7.1	1.8
1973	10.1	9.2	0.8
1974	14.7	16.0	-1.1
1975	14.9	24.2	-7.5
1976	14.7	16.6	-1.6
1977	14.4	15.9	-1.3
1978	13.7	8.3	5.0
1979	14.2	13.4	0.7

Source: Statistical Handbook of U.K. Agriculture. Wye College. October 1980.

TABLE 2. INVESTMENT APPRAISAL
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YEAR	CAPITAL	CASH FLOW	TERMINAL VALUE	INTEREST PAYMENTS	TAXATION ALLOWANCE	TAXATION PAYMENTS	NET CASH FLOW	DISCOUNTED CASH FLOW	OUTSTANDING BALANCE
	50000	0	0	0	0	0	-50000	-50000	-50000
1	0	5000	0	7500	0	0	5000	4347	-52500
2	0	5000	0	7875	0	0	5000	3780	-55375
3	0	5000	0	8306	0	0	5000	3287	-58681
4	0	5000	0	8802	0	0	5000	2858	-62483
5	0	5000	0	9372	0	0	5000	2485	-66855
6	0	5000	0	10028	0	0	5000	2161	-71884
7	0	5000	0	10782	0	0	5000	1879	-77666
8	0	5000	0	11650	0	0	5000	1634	-84317
9	0	5000	0	12647	0	0	5000	1421	-91964
10	0	5000	50000	13794	0	0	55000	13595	-50759

CASH FLOW HAS A NET PRESENT VALUE OF £-12546.915 AT 15 % DISCOUNT
CASH FLOW HAS AN INTERNAL RATE OF RETURN OF 10 %

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ASSUMPTIONS MADE IN CALCULATING D.C.F.
****

1:COST OF CAPITAL 15 %
2:MARGINAL TAX RATE 0 %
3:LAG ON TAX PAYMENTS 0 YEARS
4:CAPITAL GAINS TAX 0 %
EXPECTED INFLATION RATE:
6:LAND 0 %
10:CASH INFLOW 0 %

adjusted for inflation) internal rate of return is 9.9 per cent (Table 3)[1]. The project is correctly shown to be profitable and the farmer would proceed with the investment.

Although conceptually simple and requiring no alteration to the cash flows compiled for conventional D.C.F., this method i.e. discounting at the real rate of interest, has some significant shortcomings. In particular, it gives inaccurate information on the feasibility of a project. Interest payments are calculated at the real interest rate and are therefore grossly understated in money terms. High interest rates prove to be an onerous burden on many projects in their early years. Cash flows will often be insufficient to meet the payment of interest charges, let alone any capital repayment (Hill 1981). As a result the project's indebtedness will increase during the early years of its life.

4. THE CORRECT METHOD

The most appropriate way of countering this problem is to adjust the future cash flows for inflation. Thus, continuing with the same example, the cash flows in each year and the terminal value are compounded by the expected rate of inflation, 13 per cent (Table 4). These inflated cash flows are then discounted at the nominal rate of interest, 15 per cent. This produces results that approximate more closely to reality. It will be observed that the net present value of £37,412 is identical with that shown in Table 3. The nominal internal rate of return is 24.2 per cent. When this is converted to a real internal rate of return by adjusting for inflation (in the same way that the nominal interest rate is corrected to a real interest rate) it becomes 9.9 per cent. The results of the appraisal in terms of profitability are thus identical with those in Table 3. However, this method also gives a much more accurate estimate of the borrowing required to finance the project. Thus the investor is forewarned if a profitable investment will need additional finance to carry it through the initial period when interest payments prove to be greater than the net cash flows. In the example in Table 4, the outstanding balance can be seen to increase in the early years of the project. This shows that the farmer would require additional finance in order to undertake the project. If this is not available, then, despite its high profitability, the project would be infeasible.

If the project is to be financed by a mortgage, then the difference between the two methods is still further emphasised. Table 5 shows the balance outstanding each year on a mortgage of £50,000 repayable over 10 years at 15 per cent interest. It also shows the balance outstanding given by the two modified appraisal techniques described above.

This table shows that the net cash flow generated by the project when discounted at the real rate of interest is apparently more than sufficient to meet the interest

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[1] The interest charged in Table 3 is calculated at 1.77 per cent (the real rate of interest) of the outstanding balance. This adjustment is made because the payments are made in devalued money. This procedure will be shown to generate the correct net present value and real internal rate of return in the next section.

TABLE 3. INVESTMENT APPRAISAL
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YEAR	CAPITAL	CASH FLOW	TERMINAL VALUE	INTEREST PAYMENTS	TAXATION ALLOWANCE	TAXATION PAYMENTS	NET CASH FLOW	DISCOUNTED CASH FLOW	OUTSTANDING BALANCE
	50000	0	0	0	0	0	-50000	-50000	-50000
1	0	5000	0	885	0	0	5000	4913	-45885
2	0	5000	0	812	0	0	5000	4827	-41697
3	0	5000	0	738	0	0	5000	4743	-37435
4	0	5000	0	662	0	0	5000	4661	-33097
5	0	5000	0	585	0	0	5000	4580	-28683
6	0	5000	0	507	0	0	5000	4500	-24191
7	0	5000	0	428	0	0	5000	4422	-19619
8	0	5000	0	347	0	0	5000	4345	-14966
9	0	5000	0	264	0	0	5000	4269	-10231
10	0	5000	50000	181	0	0	55000	46149	44587

CASH FLOW HAS A NET PRESENT VALUE OF £ 37412.151 AT 1.77 % DISCOUNT
CASH FLOW HAS AN INTERNAL RATE OF RETURN OF 9.97 %

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ASSUMPTIONS MADE IN CALCULATING D.C.F.
****

1:COST OF CAPITAL 1.77 %
2:MARGINAL TAX RATE 0 %
3:LAG ON TAX PAYMENTS 0 YEARS
4:CAPITAL GAINS TAX 0 %
EXPECTED INFLATION RATE:
6:LAND 0 %
10:CASH INFLOW 0 %

TABLE 4. INVESTMENT APPRAISAL
****

YEAR	CAPITAL	CASH FLOW	TERMINAL VALUE	INTEREST PAYMENTS	TAXATION ALLOWANCE	TAXATION PAYMENTS	NET CASH FLOW	DISCOUNTED CASH FLOW	OUTSTANDING BALANCE
	50000	0	0	0	0	0	-50000	-50000	-50000
1	0	5650	0	7500	0	0	5650	4913	-51850
2	0	6384	0	7777	0	0	6384	4827	-53243
3	0	7214	0	7986	0	0	7214	4743	-54014
4	0	8152	0	8102	0	0	8152	4661	-53964
5	0	9212	0	8094	0	0	9212	4580	-52847
6	0	10409	0	7927	0	0	10409	4500	-50364
7	0	11763	0	7554	0	0	11763	4422	-46156
8	0	13292	0	6923	0	0	13292	4345	-39787
9	0	15020	0	5968	0	0	15020	4269	-30735
10	0	16972	169728	4610	0	0	186701	46149	151355

CASH FLOW HAS A NET PRESENT VALUE OF £ 37412.701 AT 15 % DISCOUNT
CASH FLOW HAS AN INTERNAL RATE OF RETURN OF 24.2 %

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ASSUMPTIONS MADE IN CALCULATING D.C.F.
****

1:COST OF CAPITAL	15 %
2:MARGINAL TAX RATE	0 %
3:LAG ON TAX PAYMENTS	0 YEARS
4:CAPITAL GAINS TAX	0 %
EXPECTED INFLATION RATE:	
6:LAND	13 %
10:CASH INFLOW	13 %

TABLE 5. A Comparison of The Outstanding Balance and Additional Finance Requirements Indicated by The Two Alternative Inflation-Adjusted Appraisal Methods.

Year	AMC Loan	Cash Flow Discounted At Real Cost of Capital		Inflated Cash Flow Discounted At Nominal Cost of Capital	
		Project's Outstanding Balance	Additional Finance Required	Project's Outstanding Balance	Additional Finance Required
	£	£	£	£	£
0	50,000	50,000	0	50,000	0
1	47,500	45,885	-1615	51,850	4,350
2	44,650	41,697	-2953	53,243	8,593
3	41,350	37,435	-3915	54,014	12,664
4	37,550	33,097	-4453	53,964	16,414
5	33,200	28,683	-4517	52,847	19,647
6	28,200	24,191	-4009	50,364	22,164
7	22,450	19,619	-2831	46,156	23,706
8	15,800	14,966	- 834	39,787	23,987
9	8,150	10,231	2081	30,735	22,585
10	0	0	0	0	0

and capital repayment requirements of the mortgage in all except the ninth year. However, the net cash flows actually generated by the project, as shown by inflating the net cash flows, can be seen by the final column to be totally inadequate to repay the mortgage. The requirement for additional finance in fact increases to a peak of nearly £24,000 in the eighth year and only ceases when the land is sold.

Although the assumption of a 100 per cent mortgage is perhaps unrealistic it does serve to highlight the problem, which will still occur with a lower percentage mortgage over a longer time period.

The problems of financing different forms of investment are dealt with in more detail in Hill, op. cit..

5. THE IMPACT OF TAXATION ON INFLATED CASH FLOWS AND TERMINAL VALUES

A further complication arises from the operation of the taxation system. Tax payments are frequently ignored in investment appraisal for the sake of simplicity, but when they are included further inaccuracies can occur.

The effects of taxation are important because tax reliefs on interest payments and allowances on capital expenditure will increase the value of the net cash flows, while tax on income and capital gains will reduce them. The higher the marginal rates of tax, the greater will be these effects. Because discounting diminishes the present value of money more the further into the future it is received, tax reliefs or payments (tax flows) have a greater impact on the project the sooner they occur. Typically, tax payments are lagged (delayed) by one or two years. Thus their present values are diminished relative to the income that generated them. Tax allowances on qualifying capital expenditure are also lagged. The effect of discounting the latter may be heightened by their timing. Claiming 100 per cent of the cost of the capital expenditure in the first year will produce a greater present value than claiming 25 per cent per year of the diminishing balance of the capital investment. This of course assumes that adequate income from either the project or other sources is available to 'use up' these allowances in the year in which they are claimed.

A further factor affecting the present value of tax flows is inflation. Their size is calculated on the money value of the cash flows. In a period of inflation, the lagging of the tax flows means that they are paid in devalued money and their value in real terms is diminished. They should therefore be discounted at the full nominal interest rate. If the tax flows were discounted at the real rate of interest their present value would be overstated, unless they occurred at the same time as the cash flows on which they were based, which is unlikely.

Where the capital investment has a value at the end of the project, liability to capital gains tax and income tax is based on the money values of the assets, not their real values. In other words, the increase in the value of the assets caused by inflation is subject to tax and this increase is not shown when discounting by the real rate of interest. It is however correctly stated when the terminal values are adjusted for inflation and discounted at the nominal rate of interest. When the effects of taxation are included, not only are the outstanding balances inaccurate when discounting at the real cost of capital, as shown above, but so too are the net present value and the internal rate of return. Tables 6 and 7 show the land purchase project appraisal when the farmer is subject to a marginal income tax rate of 50 per cent, a marginal capital gains tax rate of 30 per cent[1] and tax payments are lagged by one year. (The final year's tax liabilities are not lagged, in order to avoid complications with negative cash flows in the final year of the project's life).

Table 7 shows that the project has a true net present value of £24,724 and an internal rate of return of 30.6 per cent (15.6 per cent in real terms when adjusted for 13 per cent inflation). This compares with a net present value of £18,117 and a real internal rate of return of 9.97 per cent derived by discounting at the real cost of capital (Table 6). Thus it can be seen that not only does discounting at the real cost of capital lead to overestimates of the feasibility of the project but it also underestimates the profitability of a project when taxation effects are incorporated in the cash flow.

6. INACCURACIES IN THE CONVENTIONAL CALCULATION OF THE INTERNAL RATE OF RETURN

The inclusion of taxation in an investment appraisal causes another problem that has not been widely recognised.

The conventional method of calculating the internal rate of return is an extension of the calculation of the net present value of a series of cash flows. If the net present value is positive, the net cash flows are then discounted at a higher rate. The discount rate is increased by steps until the net present value becomes negative. The internal rate of return is then found by interpolation between the two selected discount rates giving the smallest positive and smallest negative net present values. For example, the net cash flow in Table 7 gives a positive net present value when discounted at 15 per cent. If the net cash flow is discounted at 25 per cent, then the net present value is apparently negative. Using the conventional technique, the internal rate of return is calculated to be 22.76 per cent (Table 8). This does not agree with the correct internal rate of return of 30.6 per cent shown in Table 7. The reason for the invalidity of the conventional method of calculating the internal rate of return is that no allowance is made for changes in tax liability that occur as a result of changes in the cost of capital. Thus as the discount rate increases, so too do interest payments and the tax allowances on them. These additional tax allowances increase the net cash flow and so tend to counter the effect on the net present value of using higher discount rates.

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[1] The schedule for capital gains tax is complex. For simplicity it is assumed that the farmer will be disposing of the rest of his business at the same time, so that the exemptions from tax on capital gains are used up on his other assets.

TABLE 6. INVESTMENT APPRAISAL
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YEAR	CAPITAL	CASH FLOW	TERMINAL VALUE	INTEREST PAYMENTS	TAXATION ALLOWANCE	TAXATION PAYMENTS	NET CASH FLOW	DISCOUNTED CASH FLOW	OUTSTANDING BALANCE
	50000	0	0	0	0	0	-50000	-50000	-50000
1	0	5000	0	885	0	0	5000	4913	-45885
2	0	5000	0	812	0	2057	2942	2841	-43754
3	0	5000	0	774	0	2093	2906	2757	-41623
4	0	5000	0	736	0	2112	2887	2691	-39472
5	0	5000	0	698	0	2131	2868	2627	-37302
6	0	5000	0	660	0	2150	2849	2564	-35113
7	0	5000	0	621	0	2169	2830	2503	-32905
8	0	5000	0	582	0	2189	2810	2442	-30676
9	0	5000	0	542	0	2208	2791	2383	-28428
10	0	5000	50000	503	0	4476	50523	42392	21591

CASH FLOW HAS A NET PRESENT VALUE OF £ 18116.811 AT 1.77 % DISCOUNT
CASH FLOW HAS AN INTERNAL RATE OF RETURN OF 9.97 %

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TAXATION PAYMENTS IN YEAR 10 INCLUDE:
£ 4476 INCOME TAX

ASSUMPTIONS MADE IN CALCULATING D.C.F.
****

1:COST OF CAPITAL 1.77 %
2:MARGINAL TAX RATE 50 %
3:LAG ON TAX PAYMENTS 1 YEARS
4:CAPITAL GAINS TAX 30 %
EXPECTED INFLATION RATE:
6:LAND 0 %
10:CASH INFLOW 0 %

TABLE 7. INVESTMENT APPRAISAL
****

YEAR	CAPITAL	CASH FLOW	TERMINAL VALUE	INTEREST PAYMENTS	TAXATION ALLOWANCE	TAXATION PAYMENTS	NET CASH FLOW	DISCOUNTED CASH FLOW	OUTSTANDING BALANCE
	50000	0	0	0	0	0	-50000	-50000	-50000
1	0	5650	0	7500	0	0	5650	4913	-51850
2	0	6384	0	7777	0	-925	7309	5527	-52318
3	0	7214	0	7847	0	-696	7910	5201	-52254
4	0	8152	0	7838	0	-316	8468	4842	-51623
5	0	9212	0	7743	0	157	9055	4501	-50312
6	0	10409	0	7546	0	734	9675	4182	-48183
7	0	11763	0	7227	0	1431	10331	3884	-45079
8	0	13292	0	6761	0	2267	11024	3603	-40817
9	0	15020	0	6122	0	3265	11755	3341	-35184
10	0	16972	169728	5277	0	46214	140486	34726	100024

CASH FLOW HAS A NET PRESENT VALUE OF £ 24724.471 AT 15 % DISCOUNT
CASH FLOW HAS AN INTERNAL RATE OF RETURN OF 30.6 %

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TAXATION PAYMENTS IN YEAR 10 INCLUDE:
£ 35918 CAPITAL GAINS TAX ON LAND
£ 10296 INCOME TAX

ASSUMPTIONS MADE IN CALCULATING D.C.F.
****

1:COST OF CAPITAL 15 %
2:MARGINAL TAX RATE 50 %
3:LAG ON TAX PAYMENTS 1 YEARS
4:CAPITAL GAINS TAX 30 %
EXPECTED INFLATION RATE:
6:LAND 13 %
10:CASH INFLOW 13 %

TABLE 8. Calculation of The Internal Rate of Return Using The Conventional Techniques.

Year	Net Cash Flow @ 15% Cost of Capital	Discounted Cash Flow @ 15%	Discounted Cash Flow @ 25%
	£	£	£
0	-50,000	-50,000	-50,000
1	5,650	4,913	4,520
3	7,910	5,201	4,050
4	8,468	4,842	3,472
5	9,055	4,501	2,970
6	9,675	4,182	2,535
7	10,331	3,884	2,170
8	11,024	3,603	1,852
9	11,755	3,341	1,575
10	140,486	34,726	15,032
	Net Present Value	24,724	-7,146

Internal rate of Return calculation:

$$\text{I.R.O.R.} = 15 + \left[(25-15) \times \frac{24724}{(24724 + 7146)}\right]$$

$$= 15 + \left(10 \times \frac{24724}{31870}\right) = 22.76\%$$

By ignoring these taxation effects the conventional method tends to underestimate the true internal rate of return of a project. The best way to calculate the correct internal rate of return is to amend the net cash flow suitably for each discount rate. This is obviously tedious unless a suitable computer program is available. The computer program that was written by the author[1] to investigate the effects of inflation on the discounted cash flow investment appraisal technique has such a facility.

The point made above is based on the assumption that the internal rate of return is intended to show the maximum interest rate that the project could finance. If this assumption is relaxed and the internal rate of return is only used to show (approximately) how much 'leeway' there is in the investment, and it is assumed that the interest rate calculated will never actually occur, then this inaccuracy might not be considered so important. However, it can be seen from Table 1 that the real rate of interest has varied by nearly 13 per cent between 1967 and 1975. This indicates the wide range in interest rates that can occur even over a relatively short time period, so that even a relatively large gap between the discount rate chosen and the internal rate of return may in fact be bridged.

7. THE EFFECT OF VARIATIONS IN MARGINAL TAX RATES

Where a farmer invests in a non-depreciating asset that does not attract tax allowances, such as land, the project will have the same internal rate of return irrespective of his marginal income tax rate if there is zero inflation. Thus identical projects would have to generate the same income to break even for all farmers, irrespective of their marginal tax rate. However, if the project more than breaks even, the benefits will be greater the lower the farmer's marginal tax rate (Figure 1).

If inflation is included in the calculation, then the situation changes. Identical projects will no longer have identical internal rates of return at different tax rates. The greater the tax rate, the higher will be the internal rate of return, i.e. the income required to break even will be lower for a higher rate tax payer than for a lower rate tax payer.

This situation occurs because the greater tax relief on interest payments granted to a higher rate tax payer early in the project's life outweigh the greater tax liability incurred on positive net cash flows later in the project's life, because of the effects of discounting. Thus the acceptance or rejection of a project may depend on an investor's marginal income tax rate.

This does not mean that a project will be more profitable for a higher rate tax payer at all interest rates. As can be seen from Table 9 and Figure 2, the

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[1] This program is available from Publications, School of Rural Economics, Wye College, Ashford, Kent. TN25 5AH. Price £5.00.

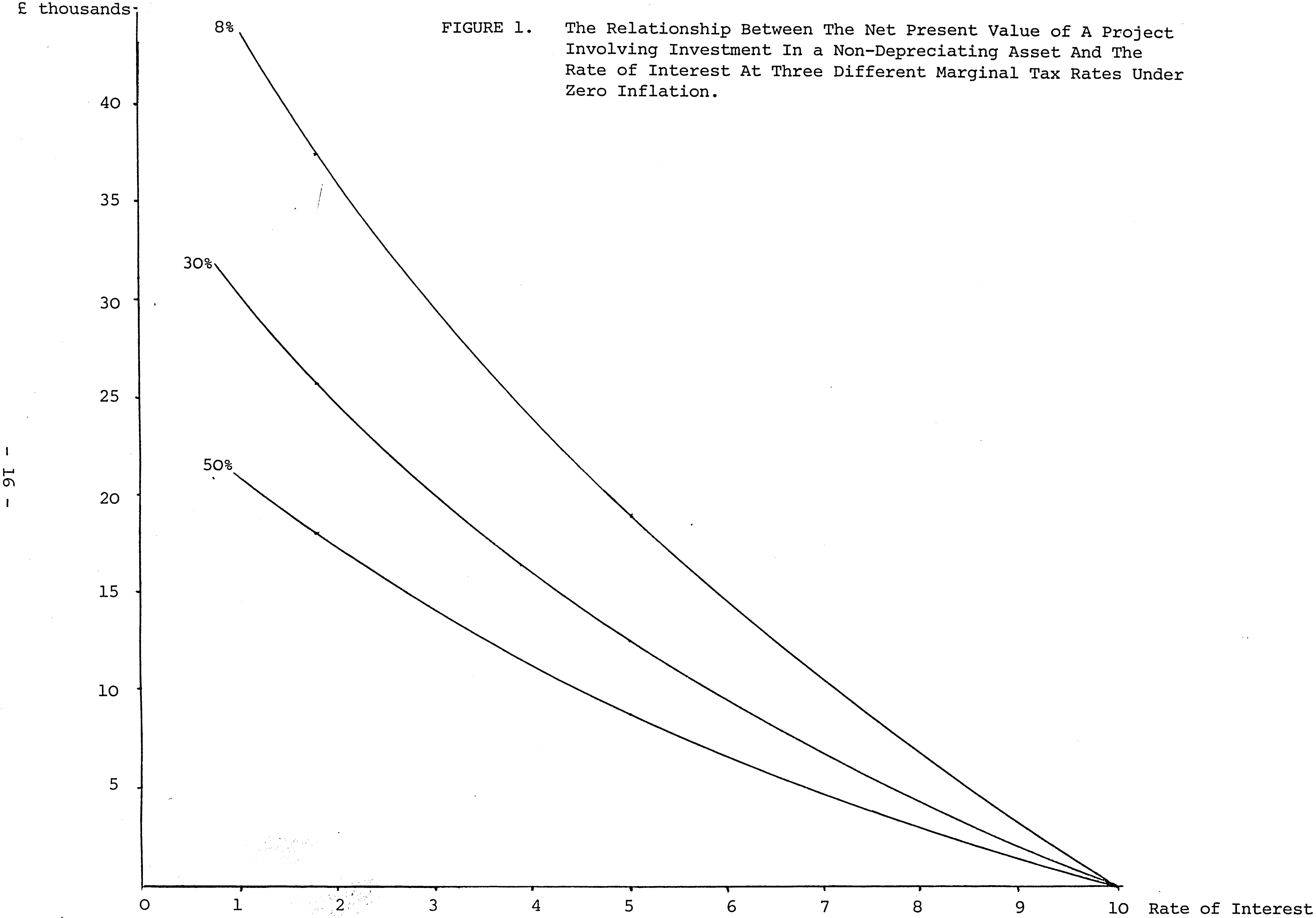


FIGURE 1. The Relationship Between The Net Present Value of A Project Involving Investment In a Non-Depreciating Asset And The Rate of Interest At Three Different Marginal Tax Rates Under Zero Inflation.

ranking between tax rates alters as nominal interest and therefore discount rates change. This occurs because as the discount rate is lowered, so the greater after tax profit for lower rate taxpayers late in the project's life increase in present value faster than the lower after tax profits of higher rate taxpayers. Eventually the present value of the net of tax cash flows of the lower rate taxpayer will exceed that of the higher rate taxpayer, and when this happens the ranking will alter. This is an example of the classic situation where a project with high net cash flows in the early years and lower ones in the later years will be more profitable than one with lower cash flows in the early years and larger ones at high discount rates. At lower discount rates the situation will be reversed, as the more distant cash flows are discounted less.

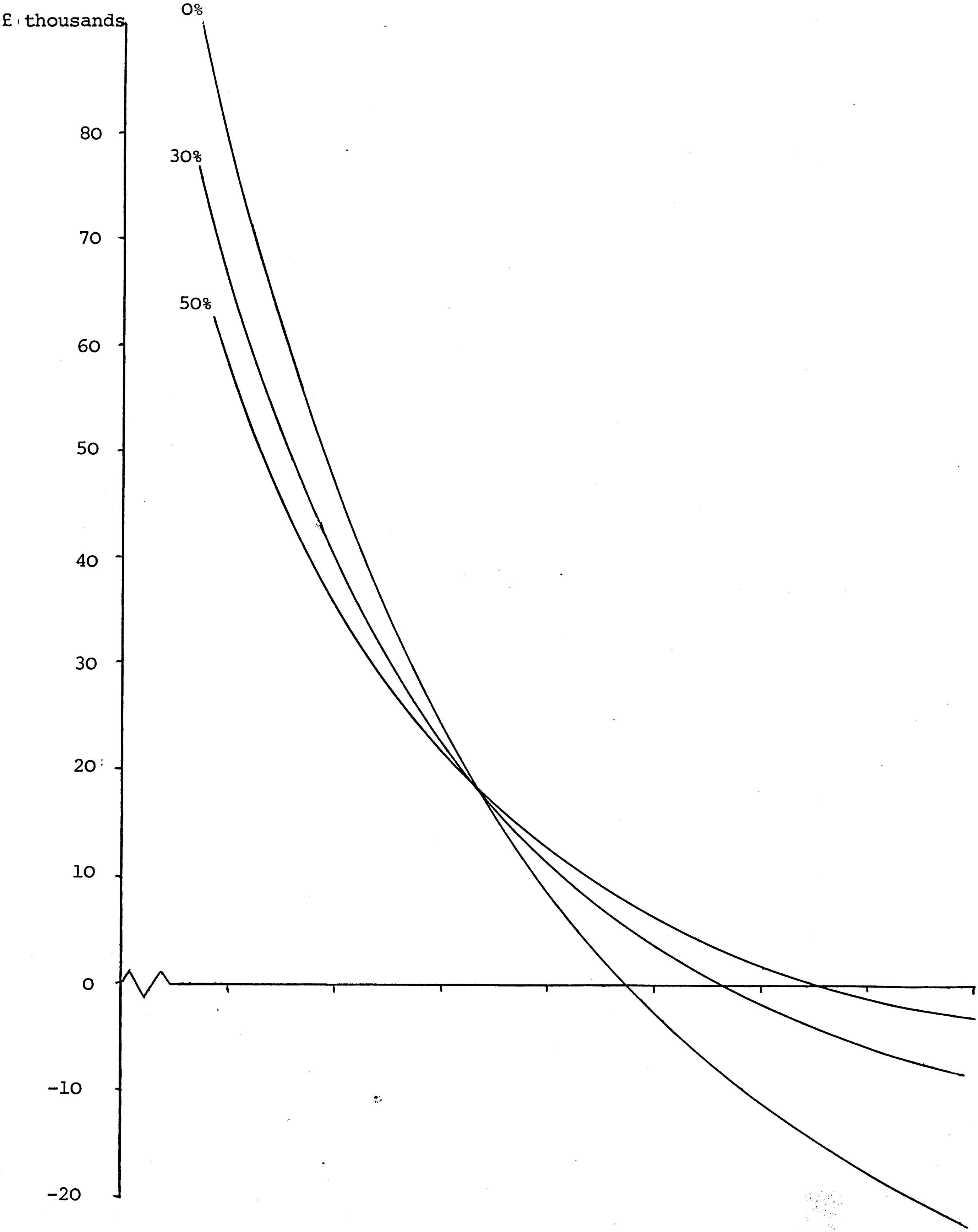
Where the asset is a depreciating one and tax allowances on the cost of it are available, the second situation occurs whether there is inflation or not, provided of course there is sufficient income to use up the tax allowances. This is because the value of the tax allowances on the capital investment, which did not occur in the previous example, are greater for a higher rate taxpayer than they are for a lower rate taxpayer. At higher discount rates these early benefits outweight the greater tax liabilities incurred later in the project's life by the higher rate taxpayer.

It is important to remember, however, that while this will lead to different investment decisions for different farmers, who pay tax at different rates, it will not affect the choice between different projects for the individual farmer.

TABLE 9. Net Present Values of a Project at Varying Costs of Capital and Taxation Rates.

INTEREST RATE (%)									
NOMINAL	8	12	16	20	24	28	32	36	40
REAL	-4.4	-0.9	2.6	6.2	9.7	13.3	16.8	20.4	23.9
MARGINAL TAX RATE									
0%	76655	45606	23745	8074	-3354	-11829	-18217	-23105	-26904
30%	63936	39353	22708	11297	3385	- 2158	- 6079	- 8878	-10893
50%	56136	35512	21792	12571	6320	2050	- 882	- 2905	- 4304

FIGURE 2. The Relationship Between The Net Present Value of a Project and the Nominal Rate of Interest At Three Different Marginal Income Tax Rates with Inflation At 13 Per Cent Per Year.



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