Notes and Comments

Tax and Credit Aids to Industrial Development in Southern Italy: A Comment on Methodology

In their interesting article, "Tax and Credit Aids to Industrial Development in Southern Italy", Professor Gardner Ackley and Dr. Lamberto Dini analyzed the influence of tax encouragements and special credit facilities on the relative attractiveness of investments in the North and South of Italy (1). One aim of this study was to set forth the effects of the encouragements on the rates of return from prospective investments under the assumption of equal operating costs in the two areas, while a second aim was to estimate the higher operating costs that could be borne in the South before the favourable influence of the special encouragements would be eliminated.

To accomplish their objectives the authors made a number of simplifying assumptions. In their introductory remarks the nature of the assumptions were clearly specified, and the reader was warned that the methods employed led to biased estimates.

The purpose of the present remarks is to explore the nature of the bias in the Ackley-Dini methodology. This is an important matter for two reasons. If the bias in the examples of the article is great, the results are misleading unless prospective investors in their own calculations employ the same methods and act upon the results. Much more important, however, is the need for investor understanding of the correct methods and the dangers involved in using simplified procedures.

In fact the results obtained in the article are reasonable approximations of the correct solutions to the cost differential problem, and moderately biased estimates of the rates of return, but this is due to the careful selection of assumptions by the authors. In particular cases in the real world there is no reason to believe that the same assumptions will be

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(1) *Banca Nazionale del Lavoro Quarterly Review*, No. 51, December 1959, pp. 3-31.

applicable, and thus the use of the method set out in the article can yield seriously misleading results.

Undoubtedly many investors, either because they are unaware of the correct procedures, or because they believe them to be too complex, will rely on some sort of simplified methods to aid them in testing the profitability of prospective investments. In a real investment situation the correct techniques, however, are not significantly more difficult than the simplified methods. While in the article the problem was to make a large number of comparisons of cases which did not differ fundamentally, and for which the basic data such as investment outlay and operating costs were inexpensive and easy to obtain, in the real investment situation the problem is generally to compare a few alternatives which may differ fundamentally in the time structure of returns and longevity of plant and equipment, and for which the information concerning operating costs and investment requirements will be time consuming and costly to acquire. Once the relevant information is assembled it will require a very small amount of extra effort to compute returns and cost differentials by the correct methods, so that the use of rules of thumb is simply not justifiable.

In what follows the nature of the correct compound interest approach to the problems will be presented, and the results obtained with this procedure will be compared with those obtained with the method employed in the article.

The analytical procedure employed by Professor Ackley and Dr. Dini may be designated as the "Initial Book Value Method" (IBVM). With this technique rates of return are computed by estimating annual accounting profits and dividing this figure by the capitalized initial investment. It was assumed in some Northern cases, for example, that initial investment was 1,474.6 while gross profits were 250, from which 95.7 of depreciation, computed with a straight-line formula, and 47 of interest charges were deducted to obtain a net annual profit of 107.3. This last figure divided by total investment yielded a profit before income tax of 7.3% (2).

From an accounting point of view this figure might be considered reasonable, but the problem at hand is not to estimate a reasonable accounting figure for the profit of past operations. Here we are dealing with the economic problem of forecasting future prospective profitability. It is essentially because an index of profitability appropriate for accounting purposes is applied to a problem requiring an economic index that the bias arises. The economic question is: What rate of return is asso-

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(2) *Ibid.*, Table IV, p. 22.

ciated with a stream of future receipts and payments if this stream cost a certain sum today? The answer to this query requires the use of compound interest computations which give weight to the fact that a sum of money received or paid in the future is not worth the same amount from the standpoint of the present.

Before analyzing the relationship between the correct compound interest methods and IBVM, one important point must be considered. The Italian laws include two essentially different types of encouragements, loans at low interest rates and various tax reductions and subsidies. While for accounting purposes interest on loans may be deducted from gross profits to obtain a net profit figure, the rate of return derived from this procedure does not aid in answering the economic questions. From an economic point of view the low interest rate loans have no effect at all on the profitability of an opportunity taken as a whole. The economic return is independent of the method of financing the project. What the loan does is to give an investor greater ability to undertake a project. Alternatively it may be considered as a factor which lowers the minimum acceptable rate of return which the investment must yield before it will be undertaken. The loan consequently may make investments with a given rate of return worthwhile when they would not be without it even though the rate of return is not affected.

From an economic point of view the loan does affect one particular rate of return directly. That is the rate of return on the investor's own capital or equity. If it is desired to find the return on equity, which after all is very important, then the loan must be considered as a receipt which lowers the investor's initial outlay just as does a direct subsidy, and the interest and amortization payments will be taken into account along with other future cost outlays in the computation of the rate of return. In the IBVM with a loan, however (since the numerator is influenced by the loan, while the denominator is not), the rate of return computed is neither the rate of return on the investment as a whole, nor the rate of return on equity, but some sort of average of these which has no true economic significance. To correspond to the economic concepts either the interest must be removed from the numerator or the denominator must include only equity capital.

Although it is a simple matter to compute the influence of a loan on the rate of return on equity capital, in the subsequent analysis this has not been done, because, as a general principle, it is better to treat separable decisions separately. Decisions concerning the appropriate methods of financing a project are usually separable from those which are

based on the profitability of the investment as a whole, and it is this latter figure which is of special interest here.

The first step in the correct compound interest calculations is the setting down of the relevant cash flows. In the case of the Northern investment and the Southern investment using imported machinery these are as follows (3).

Cash Flows (4)

Year	Item	North	South
0	Initial investment	−1,474.6	−1,159.6 (5)
1-10	Gross receipts	+ 250.0	+ 250.0
10	Remaining value of investment (6) .	+ 518	+ 518

The second step in the process is to find the rate of interest which equates the future cash flow to the initial investment outlay. This rate of interest is the rate of return on the initial investment. It means that the predicted cash flows are sufficient to repay the initial investment with annual compound interest of (i) percent (7). In this case the approximate compound interest rate of return is 13.5% in the North and 19.4% in the South, while the Initial Book Value Method yields 10.47% in the North and 15.4% in the South.

The algebraic analysis of the bias involved in the Initial Book Value Method is carried out in Appendix B below. It is there demonstrated that if the investment opportunities are of the type which yield equal annual gross returns such as the (+250) in the example above, then the difference between the rate of return obtained with the Initial Book Value Method (r) and the true compound interest rate of return (i) will be greater, 1) the higher is (i), 2) the lower the remaining value after the

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(3) Data from *ibid.*, Table III and Table IV (B) North and South Case A.

(4) Positive sign indicates a receipt; negative sign indicates a payment.

(5) The Southern initial investment in Table IV of the article is reported as 1259.6. This involves a computational error of +100 which was made in the case of each example of Southern investment. The "rates of return" computed in the article for Southern investment are consequently in error.

(6) The remaining value is assumed to consist of the recovery of working capital (+300), and two thirds of the initial value of Northern structures (+218). Since the life of these structures was assumed to be 30 years, they may reasonably be expected to have depreciated by a third after 10 years. The Northern value is taken for the Southern investment because this is thought to reflect adequately the influence of the incentives on the return from Southern investments in the period beyond 10 years, i.e., after the subsidized machinery with a 10 year life must be replaced.

(7) The actual calculations are set out in Appendix A below.

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study period is over. If the study period is one year, or if the remaining value after any study period is equal to the initial investment, then (r) estimates (i) exactly. The (r) will estimate a given (i) less well as the study period lengthens beyond one year until a maximally poor value is reached, and then for longer periods the estimate improves again. As (i) increases the poorest estimate is reached at an ever shorter study period. With no remaining value and a 10 year study period, (i-r)=3.7 percentage points when i=10%, i.e., r=6.3%. With a 10 year study period, no remaining value and i=20%, r=13.8%. The value of (i-r) will be cut proportionally as remaining value increases. Thus if the value of the investment at the end of the study period is depreciated to one half the initial value and if we assume the ten year period with i=10%, (i-r)=(3.7)(1-.5)=1.85 points, i.e., r=8.15%.

The assumption made in the above analysis concerning the structure of the investment opportunities were very favourable for the Initial Book Value Method. Indeed, if only the higher operating costs that can be borne in the South before the favourable influence of the special encouragements is eliminated are required, then, provided that the structure of the Northern and Southern investments are the same, so that differences are in the scale of the opportunities only, the Initial Book Value Method will yield the same result as the correct method (8). The cases used in the original article almost meet this requirement. In the illustrative case above for example the correct cost differential is 5.9% when sales are 1,250 in the North and South and costs in the North are 1,000, while the IBVM estimate is 5.7% (9).

To this point, the analysis has emphasized the conditions required for minimum bias in using the IBVM. Earlier, however, it was stated that these conditions often will not obtain in the real world, and that if they do not, then the IBVM may yield grossly incorrect solutions. To

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(8) For identical results the ratio of initial investment to remaining value after the study period must be the same in both the North and the South. In the example above this requirement is not met exactly if a ten year study period is employed, because of the assumption that the remaining value of Southern structures is equal to that of Northern structures. If this assumption is not made the value of the encouragements will be underestimated because no weight will be given to their effects beyond the 10 year period. On the other hand, if a 30 year study period is chosen so that all capital will be fully depreciated, then the IBVM loses its simplicity, for the total amount of depreciation during years 11-20 will differ from that during years 1-10.

(9) The nature of this calculation is discussed in Appendix A below. The calculations in the article meet the requirements for perfect estimation of cost differentials, except for the treatment of loans. However, in meeting this standard the influence of the period beyond the life of machinery is neglected.

illustrate this fact consider the following case (10). Two investment pro-
posals, a vacuum still and a product terminal, are competing for limited
funds in an oil company. Each requires an immediate disbursement of
110,000 all of which will be capitalized. Straight-line depreciation will
be used in the accounts, and in both cases expected life is 10 years with
zero salvage value. The estimated positive cash flow from the vacuum
still will be 38,000 the first year, 34,000 the second year and will diminish
by 4,000 a year until it is 2,000 in the tenth year. The estimated positive
cash flow resulting from the product terminal will be 5,000 the first year,
9,000 in the second, and will increase by 4,000 a year until it is 41,000
in the tenth year.

The correct compound interest rate of return on the vacuum still is
approximately 19%, while the correct return from investment in the
product terminal is approximately 12%. Application of the IBVM which
yields an average annual profit of 9,000 for the still and 12,000 for the
terminal, however, results in "rates of return" of 8.2% on the vacuum
still and 10.9% on the product terminal. *In this example the IBVM bias
is sufficient to rank the two projects in incorrect order.* Variations of
the IBVM such as taking the average book value instead of the initial
book value for the denominator in the "rate of return" calculation still
yield this anomalous result.

In general it may be said that the bias involved in computing rates
of return by the IBVM or its common variants will vary from the estim-
ates computed here as the structure of the investment opportunities vary
from the case of steady gross receipts, and in some cases the bias will
be sufficient to rank projects incorrectly, thus leading to improper invest-
ment decisions. Moreover, the simplicity of the Book Value Methods
diminishes when it is not reasonable to assume simple straight-line depre-
ciation over the life of the investment as may well be the case, for
example, in a country which allows other methods for tax purposes.
Finally, the fact that the methods rely on the capitalized book value of
the investment as a component of the denominator in computing rates
of return means that variations in that part of the initial outlay which
can be so treated will influence the rate of return calculation, when, from
the economic point of view, this has no direct bearing on the issue (11).

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(10) Based on an example used in E. L. GRANT and W. L. IRESON, *Principles of Engi-
neering Economy*, 4th ed.; New York: The Ronald Press Co., 1960, p. 175 ff.

(11) The correct methods take such differences into consideration insofar as they
influence actual cash flows, which they will do in the computation of the rate of return
after income tax, but not before income tax.

Appendix A.

Illustrations of Compound Interest Calculations.

The rate of return computations may be illustrated by going through
the steps required to reach the 13.5% figure for Northern investment.

(1) The cash flows are:

Year	Amount
0	—1,474.6
1-10	+ 250
10	+ 518

(2) The interest rate which equates these cash flows to zero must
be found. The (—1,474.6) investment made in year (0), of course, is not
discounted. The positive flow of 250 for 10 years must be discounted
with the series present worth factor, $\dfrac{(1+i)^n-1}{i(1+i)^n}$ with $n=10$. The 518
remaining value at the end of the tenth year must be discounted using
the single payment present worth factor, $\dfrac{1}{(1+i)^n}$ with $n=10$.

(3) It is clear that the 250 per year for ten years will dominate the
positive values. Inspection of a 15% table reveals that the series present
worth factor is about 5, and this multiplied times 250 equals 1,250. It
is therefore clear that the rate of return is less than 15%. In fact the
present worth of the cash flows at 15% is:

$$(5.019)(250)+(.2472)518-1474.6=-92.*$$

(4) The same procedure with a 12% interest rate yields a present
worth of +105. It is therefore known that the true rate of return lies
between 12% and 15%.

(5) To approximate the true rate of return a linear interpolation is
made as follows. It is noted that the distance between the present worths
at 12% and 15% is (92+105)=197, and that the distance of the present
worth at 12% from zero is 105. The estimate is then:

$$i=12\%+(15\%-12\%)\frac{105}{197}=13.6\%$$

(*) 5.019 is the series present worth factor, and .2472 is the single payment present
worth factor for $i=15\%$, $n=10$.

(6) This is, of course, only an approximation, but it will generally yield results which are inaccurate only in the first decimal place. The result is generally a little higher than the true rate, which may be estimated more closely by continuing the process outlined here or by using some other procedure such as Newton's method.

(7) To compute the cost differential it is necessary to find the annual gross operating profit (G) in the South that will yield the Northern return (13.5%) on the Southern investment (— 1159.6). In other words it is necessary that:

$$\frac{[(1.135)^{10}-1]\ G}{.135\,(1.135)^{10}} + \frac{1}{(1.135)^{10}}\ 518 - 1,159.6 = 0.$$

$$G = 190.6$$

(8) Since sales (S) less operating costs (C) equal gross profits (G), S-G=C. If sales are 1,250, C=1,059.4. Thus if Northern costs are 1,000, Southern costs may be 5.9% higher, and the Southern investment will still yield 13.5%.

Appendix B.

Comparison of Initial Book Value and Compound Interest Methods
Symbols:

r = rate of return with IBV method;

i = rate of return with compound interest method;

G_a = gross annual operating profits with IBV method;

G = gross annual operating profits with compound interest method;

I_0 = initial investment;

I_n = remaining value of investment after study period;

n = study period in years;

(ssf-i-n) = sinking fund factor $= \dfrac{1}{(1+i)^n - 1}$

D_{sl} = annual straight-line depreciation;

t = the ratio of final value to initial investment $= \dfrac{I_n}{I_0}$

(a) It can be shown that the (G) required to yield a given (i) may be computed with the following formula:

1. $G = (I_0 - I_n)\,(\text{ssf-i-n}) + I_0 i,$

(b) From the definition of the IBV method:

2. $r = \dfrac{G_a - D_{sl}}{I_0}$

3. $D_{sl} = \dfrac{I_0 - I_n}{n}$

(c) From (2) and (3):

4. $G_a = (I_0 - I_n)\,\dfrac{1}{n} + I_0 r.$

(d) In the rate of return calculations it is assumed that gross annual operating profits are known and equal in the North and South, i.e., $G_a = G$. From this assumption using (1) and (4):

5. $r = \left[(\text{ssf-i-n}) - \dfrac{1}{n}\right]\left[1 - \dfrac{I_n}{I_0}\right] + i,$

(e) From (5) it is clear that if $I_n = I_0$, or if $(\text{ssf-i-n}) = \dfrac{1}{n}$, then (r) estimates (i) exactly. The former holds if there is no depreciation, while the latter holds for one year study periods.

(f) Illustrative values of (i-r) in percentage points are presented in Table I under the assumption that $I_n = 0$.

TABLE I

n	(i-r) i=10%	i=20%
1	0	0
2	2.9	4.6
4	3.5	6.4
10	3.7	6.2
20	3.3	4.5
50	2.0	2.0

(g) As (t) increases (i-r) decreases proportionally. For example, if $t = .5$, the (i-r) values for Table I are halved.

(h) The IBV method will estimate exactly the tolerable cost differentials if Northern and Southern investments follow the pattern assumed here. If (t) is different in the North and South, as it seems reasonable to assume, then an element of bias is introduced even when investments are assumed to yield equal (G's) in each year. This is also a source of bias in the computation of (r) in the cases used in the Ackley-Dini article. Since D_{s1} in the Southern cases does not provide the best estimate of I_n for structures (i-r), will be slightly larger than indicated in Table I above.

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