EVALUATING INVESTMENT DECISIONS OF AGRIBUSINESS FIRMS

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Prepared by J. W. Gruebele, Professor of Dairy Marketing, and T. L. Frey, Associate Professor of Agricultural Finance, Department of Agricultural Economics, University of Illinois at Urbana-Champaign.

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Almost every business or person will at some time face the problem of making long-term investments. In the course of operating a business, agricultural or otherwise, a manager must make decisions on whether to replace or add the fixed assets used in the business. Trucks, machinery, and buildings are expensive. A decision to go ahead with one of these items uses up a substantial portion of the firm's cash or borrowing reserves.

In particular, agribusiness firms face decisions regarding the acquisition of resources. With the dramatic increase in the quantity of resources needed to operate a viable business, the need for credit has increased substantially. As a result, there are serious consequences if errors are made in investment decisions. A firm is faced with many questions — How many assets should be added? Which assets? How should they be acquired? Alternative methods of acquisition include cash or credit purchase of assets, financial lease, operating lease, and custom hire.

To evaluate alternative capital investments, several methods, including the following, have been used: payback, average rate of return, internal rate of return, and net present value. The last two approaches involve discounting the cash inflows and outflows associated with the investments. Unlike payback and average rate of return, they take into account the time value of money — which is becoming more critical with the current high interest rates. Thus, the internal rate of return and the net present value methods are discussed in this circular, in forms in which they can be used by agribusiness firms.[1]

TIME VALUE OF MONEY

To appreciate and understand the analysis of investment decisions, several concepts are basic. The relationship between time and the value of a given amount of money is central to a discussion of these concepts.

Compounding and Discounting

Anyone who puts money in a savings account to earn interest appreciates that a given sum of money invested today at interest will grow with time. One dollar invested today at 6 percent compounded annually will be worth $1.06 at the end of the first year, $1.124 at the end of the second year, and $1.191 at the end of the third year.

The reverse of compounding is discounting. The question is, "What is the value today (*the present value*) of an amount that will be received at a time in the future?" For example, the present value of $1.06 to be received one year from now, if discounted at 6 percent annually, is $1.00. Stated another way, the present value (P.V.) of a sum of money reflects

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[1] For a discussion of the payback approach and the average rate of return, see Frank J. Smith and Ken Cooper, *The Financial Management of Agribusiness Firms,* University of Minnesota, Agricultural Extension Service Special Report No. 26, September, 1967, pages 69-71.

the amount of money that would have to be invested today, at the given interest rate, to end up with an amount equal to the future sum in question.

Discounting is really just a multiplication process: P.V. = future sum $\times \frac{1}{1 + i}$, where i is the interest rate.

Restating the problem just given, P.V. = \$1.06 $\times \frac{1}{1.06}$. In this case it is easy to see that P.V. = \$1.00. To simplify matters for more complicated cases, Table 1 reports the factors for $\frac{1}{1 + i}$ at various interest rates and for money received at the end of several different years. The present value, for example, of \$100 to be received 10 years from now at 8 percent interest would be \$46.30 (\$100 × .463).

So far, the present value of one sum of money to be received at a specific time in the future has been considered. A related topic concerns the present value of a stream of money, where each year the same amount is received (an annuity). If A is the constant amount to be received each year, then P.V. = $A\left(\frac{1}{1 + i}\right) + A\left(\frac{1}{1 + i^2}\right) + \ldots + A\left(\frac{1}{1 + i^n}\right)$, where n is the number of years for which the money is received. Rather than use Table 1 to find a present value for each separate term and add them together for the total present value, use Table 2, which lists the appropriate factors for equivalent amounts received for multiple years.

For example, determine the P.V. of a \$100 annuity to be received for each of the next 10 years, assuming 6 percent interest. In Table 2, under 6 percent interest, and at the 10th year, the factor is 7.360. Multiplying \$100 × 7.360 gives a present value of \$736.

Opportunity Cost

A resource can be used or invested in only one way, even though many alternative uses may exist. When resources are used to produce a specific product, certain quantities of other products are foregone which those resources could have produced. What is given up can be thought of as a cost, in the sense that it cannot be received. The opportunity cost of a resource to a firm is defined as the amount that the resource would have earned in its most profitable alternative use. Even if a firm has only one project in which it can invest (an unlikely possibility), it would have the alternative of putting money in a savings account. In such a case the opportunity cost would be the unrealized interest from the savings account.

Cost of Capital

In the discounting section above, the interest rate (i) was obviously a key determinant of the present value. For investment decisions, the

Table 1. Present Value of $1 for Selected Years and Interest Rates (Smith and Cooper, p. 55)

Year hence	1%	2%	4%	6%	8%	10%	11%	12%	13%	14%	15%	16%	17%	18%	20%	22%	24%	25%	30%	35%	40%	45%	50%
1	0.990	0.980	0.962	0.943	0.926	0.909	0.901	0.893	0.885	0.877	0.870	0.862	0.855	0.847	0.833	0.820	0.806	0.800	0.769	0.741	0.714	0.670	0.667
2	0.980	0.961	0.925	0.890	0.857	0.826	0.812	0.797	0.783	0.769	0.756	0.743	0.731	0.718	0.694	0.672	0.650	0.640	0.592	0.549	0.510	0.476	0.444
3	0.971	0.942	0.889	0.840	0.794	0.751	0.731	0.712	0.693	0.675	0.658	0.641	0.624	0.609	0.579	0.551	0.524	0.512	0.455	0.406	0.364	0.328	0.296
4	0.961	0.924	0.855	0.792	0.735	0.683	0.659	0.636	0.613	0.592	0.572	0.552	0.534	0.516	0.482	0.451	0.423	0.410	0.350	0.301	0.260	0.226	0.198
5	0.951	0.906	0.822	0.747	0.681	0.621	0.593	0.567	0.543	0.519	0.497	0.476	0.456	0.437	0.402	0.370	0.341	0.328	0.269	0.223	0.186	0.156	0.132
6	0.942	0.888	0.790	0.705	0.630	0.564	0.535	0.507	0.480	0.456	0.432	0.410	0.390	0.370	0.335	0.303	0.275	0.262	0.207	0.165	0.133	0.108	0.088
7	0.933	0.871	0.760	0.665	0.583	0.513	0.482	0.452	0.425	0.400	0.376	0.354	0.333	0.314	0.279	0.249	0.222	0.210	0.159	0.122	0.095	0.074	0.059
8	0.923	0.853	0.731	0.627	0.540	0.467	0.434	0.404	0.376	0.351	0.327	0.305	0.285	0.266	0.233	0.204	0.179	0.168	0.123	0.091	0.068	0.051	0.039
9	0.914	0.837	0.703	0.592	0.500	0.424	0.391	0.361	0.333	0.308	0.284	0.263	0.243	0.225	0.194	0.167	0.144	0.134	0.094	0.067	0.048	0.035	0.026
10	0.905	0.820	0.676	0.558	0.463	0.386	0.352	0.322	0.295	0.270	0.247	0.227	0.208	0.191	0.162	0.137	0.116	0.107	0.073	0.050	0.035	0.024	0.017
11	0.896	0.804	0.650	0.527	0.429	0.350	0.317	0.287	0.261	0.237	0.215	0.195	0.178	0.162	0.135	0.112	0.094	0.086	0.056	0.037	0.025	0.017	0.012
12	0.887	0.788	0.625	0.497	0.397	0.319	0.286	0.257	0.231	0.208	0.187	0.168	0.152	0.137	0.112	0.092	0.076	0.069	0.043	0.027	0.018	0.012	0.008
13	0.879	0.773	0.601	0.469	0.368	0.290	0.258	0.229	0.204	0.182	0.163	0.145	0.130	0.116	0.093	0.075	0.061	0.055	0.033	0.020	0.013	0.008	0.005
14	0.870	0.758	0.577	0.442	0.340	0.263	0.232	0.205	0.181	0.160	0.141	0.125	0.111	0.099	0.078	0.062	0.049	0.044	0.025	0.015	0.009	0.006	0.003
15	0.861	0.743	0.555	0.417	0.315	0.239	0.209	0.183	0.160	0.140	0.123	0.108	0.095	0.084	0.065	0.051	0.040	0.035	0.020	0.011	0.006	0.004	0.002
16	0.853	0.728	0.534	0.394	0.292	0.218	0.188	0.163	0.141	0.123	0.107	0.093	0.081	0.071	0.054	0.042	0.032	0.028	0.015	0.008	0.005	0.003	0.002
17	0.844	0.714	0.513	0.371	0.270	0.198	0.170	0.146	0.125	0.108	0.093	0.080	0.069	0.060	0.045	0.034	0.026	0.023	0.012	0.006	0.003	0.002	0.001
18	0.836	0.700	0.494	0.350	0.250	0.180	0.153	0.130	0.111	0.095	0.081	0.069	0.059	0.051	0.038	0.028	0.021	0.018	0.009	0.005	0.002	0.001	0.001
19	0.828	0.686	0.475	0.331	0.232	0.164	0.138	0.116	0.098	0.083	0.070	0.060	0.051	0.043	0.031	0.023	0.017	0.014	0.007	0.003	0.002	0.001	0.000
20	0.820	0.673	0.456	0.312	0.215	0.149	0.124	0.104	0.087	0.073	0.061	0.051	0.043	0.037	0.026	0.019	0.014	0.012	0.005	0.002	0.001	0.001	0.000
21	0.811	0.660	0.439	0.294	0.199	0.135	0.112	0.093	0.077	0.064	0.053	0.044	0.037	0.031	0.022	0.015	0.011	0.009	0.004	0.002	0.001	0.000	0.000
22	0.803	0.647	0.422	0.278	0.184	0.123	0.101	0.083	0.068	0.056	0.046	0.038	0.032	0.026	0.018	0.013	0.009	0.007	0.003	0.001	0.001	0.000	0.000
23	0.795	0.634	0.406	0.262	0.170	0.112	0.091	0.074	0.060	0.049	0.040	0.033	0.027	0.022	0.015	0.010	0.007	0.006	0.002	0.001	0.000	0.000	0.000
24	0.788	0.622	0.390	0.247	0.158	0.102	0.082	0.066	0.053	0.043	0.035	0.028	0.023	0.019	0.013	0.008	0.006	0.005	0.002	0.001	0.000	0.000	0.000
25	0.780	0.610	0.375	0.233	0.146	0.092	0.074	0.059	0.047	0.038	0.030	0.024	0.020	0.016	0.010	0.007	0.005	0.004	0.001	0.001	0.000	0.000	0.000
30	0.742	0.552	0.308	0.174	0.099	0.057	0.044	0.033	0.026	0.020	0.015	0.012	0.009	0.007	0.004	0.003	0.002	0.001	0.000	0.000	0.000	0.000	0.000
35	0.706	0.500	0.253	0.130	0.068	0.036	0.026	0.019	0.014	0.010	0.008	0.006	0.004	0.003	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000
40	0.672	0.453	0.208	0.097	0.046	0.022	0.015	0.011	0.008	0.005	0.004	0.003	0.002	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
45	0.639	0.410	0.171	0.073	0.031	0.014	0.009	0.006	0.004	0.003	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
50	0.608	0.372	0.141	0.054	0.021	0.009	0.005	0.003	0.002	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Prepared by Henry Hwang, research specialist, Department of Agricultural Economics, University of Minnesota.

Table 2. Present Value of $1 Received Annually at the End of Each Year for N Years at Various Rates of Interest (Smith and Cooper, p. 60)

Year (N)	1%	2%	4%	6%	8%	10%	11%	12%	13%	14%	15%	16%	17%	18%	20%	22%	24%	25%	30%	35%	40%	45%	50%
1	0.990	0.980	0.962	0.943	0.926	0.909	0.901	0.893	0.885	0.877	0.870	0.862	0.855	0.848	0.833	0.820	0.807	0.800	0.769	0.741	0.714	0.690	0.667
2	1.970	1.942	1.886	1.883	1.783	1.736	1.713	1.690	1.668	1.647	1.626	1.605	1.585	1.566	1.528	1.492	1.457	1.440	1.361	1,289	1.225	1.165	1.111
3	2.941	2.884	2.775	2.673	2.577	2.487	2.444	2.402	2.361	2.322	2.283	2.246	2.210	2.174	2.107	2.042	1.981	1.952	1.816	1.696	1.589	1.493	1.407
4	3.902	3.808	3.630	3.465	3.312	3.170	3.102	3.037	2.975	2.914	2.855	2.798	2.743	2.690	2.589	2.494	2.404	2.362	2.166	1.997	1.849	1.720	1.605
5	4.853	4.714	4.452	4.212	3.993	3.791	3.696	3.605	3.517	3.433	3.352	3.274	3.199	3.127	2.991	2.864	2.745	2.689	2.436	2.220	2.035	1.876	1.737
6	5.796	5.601	5.242	4.917	4.623	4.355	4.231	4.111	3.998	3.889	3.785	3.685	3.589	3.498	3.326	3.167	3.021	2.951	2.643	2.385	2.168	1.983	1.824
7	6.728	6.472	6.002	5.582	5.206	4.868	4.712	4.564	4.423	4.288	4.160	4.039	3.922	3.812	3.605	3.416	3.242	3.161	2.802	2.508	2.263	2.057	1.883
8	7.652	7.326	6.733	6.210	5.747	5.335	5.146	4.968	4.799	4.639	4.487	4.344	4.207	4.078	3.837	3.619	3.421	3.329	2.925	2.598	2.331	2.109	1.922
9	8.566	8.162	7.435	6.802	6.247	5.759	5.537	5.328	5.132	4.946	4.772	4.607	4.451	4.303	4.031	3.786	3.566	3.463	3.019	2.665	2.379	2.144	1.948
10	9.471	8.983	8.111	7.360	6.710	6.145	5.889	5.650	5.426	5.216	5.019	4.833	4.659	4.494	4.193	3.923	3.682	3.571	3.092	2.715	2.414	2.168	1.965
11	10.368	9.787	8.761	7.887	7.139	6.495	6.207	5.938	5.687	5.453	5.234	5.029	4.836	4.656	4.327	4.035	3.776	3.656	3.147	2.752	2.438	2.185	1.977
12	11.255	10.575	9.385	8.384	7.536	6.814	6.492	6.194	5.918	5.660	5.421	5.197	4.988	4.793	4.439	4.127	3.851	3.725	3.190	2.779	2.456	2.197	1.985
13	12.134	11.348	9.986	8.853	7.904	7.103	6.750	6.424	6.122	5.842	5.583	5.342	5.118	4.910	4.533	4.203	3.912	3.780	3.223	2.799	2.469	2.205	1.990
14	13.004	12.106	10.563	9.295	8.244	7.367	6.982	6.628	6.303	6.002	5.725	5.468	5.229	5.008	4.611	4.265	3.962	3.824	3.249	2.814	2.478	2.210	1.993
15	13.865	12.849	11.118	9.712	8.560	7.606	7.191	6.811	6.462	6.142	5.847	5.576	5.324	5.092	4.676	4.315	4.001	3.859	3,268	2.826	2.484	2.214	1.995
16	14.718	13.578	11.652	10.106	8.851	7.824	7.379	6.974	6.604	6.265	5.954	5.669	5.405	5.162	4.730	4.357	4.033	3.887	3.283	2.834	2.489	2.216	1.997
17	15.562	14.292	12.166	10.477	9.122	8.022	7.549	7.120	6.729	6.373	6.047	5.749	5.475	5.222	4.775	4.391	4.059	3.910	3.295	2.840	2.492	2.218	1.998
18	16.399	14.992	12.659	10.828	9.372	8.202	7.702	7.250	6.840	6.468	6.123	5.818	5.534	5.273	4.812	4.419	4.080	3.928	3.304	2.844	2.494	2.219	1.999
19	17.226	15.679	13.134	11.158	9.604	8.365	7.839	7.366	6.938	6.550	6.198	5.878	5.585	5.316	4.844	4.442	4.097	3.942	3.311	2.848	2.496	2.220	1.999
20	18.046	16.352	13.590	11.470	9.818	8.514	7.963	7.470	7.025	6.623	6.259	5.929	5.628	5.353	4.870	4.460	4.110	3.954	3.316	2.850	2.497	2.221	1.999
21	18.857	17.011	14.029	11.764	10.017	8.649	8.075	7.562	7.102	6.687	6.313	5.973	5.665	5.384	4.891	4.476	4.121	3.963	3.320	2.852	2.498	2.221	2.000
22	19.661	17.658	14.451	12.042	10.201	8.772	8.176	7.645	7.170	6.743	6.359	6.011	5.696	5.410	4.909	4.488	4.130	3.971	3.323	2.853	2.499	2.222	2.000
23	20.456	18.292	14.857	12.304	10.371	8.883	8.267	7.718	7.230	6.792	6.399	6.044	5.723	5.432	4.925	4.499	4.137	3.976	3.325	2.854	2.499	2.222	2.000
24	21.244	18.914	15.247	12.551	10.529	8.985	8.348	7.784	7.283	6.835	6.434	6.073	5.747	5.451	4.937	4.507	4.143	3.981	3.327	2.855	2.499	2.222	2.000
25	22.024	19.524	15.622	12.784	10.675	9.077	8.422	7.843	7.330	6.783	6.464	6.097	5.766	5.467	4.948	4.514	4.147	3.985	3.329	2.856	2.499	2.222	2.000
30	25.808	22.397	17.292	13.765	11.258	9.427	8.694	8.055	7.496	7.003	6.566	6.177	5.829	5.517	4.979	4.534	4.160	3.995	3.332	2.857	2.500	2.222	2.000
35	29.409	24.999	18.665	14.498	11.655	9.644	8.855	8.176	7.586	7.070	6.617	6.215	5.858	5.539	4.992	4.541	4.164	3.998	3.333	2.857	2.500	2.222	2.000
40	32.835	27.356	19.793	15.047	11.925	9.779	8.951	8.244	7.634	7.105	6.642	6.234	5.871	5.548	4.997	4.544	4.166	3.999	3.333	2.857	2.500	2.222	2.000
45	36.095	29.490	20.720	15.456	12.109	9.863	9.008	8.283	7.661	7.123	6.654	6.242	5.877	5.552	4.999	4.545	4.166	4.000	3.333	2.857	2.500	2.222	2.000
50	39.197	31.424	21.482	15.762	12.234	9.915	9.042	8.305	7.676	7.133	6.661	6.246	5.880	5.554	4.999	4.545	4.167	4.000	3.333	2.857	2.500	2.222	2.000

Prepared by Henry Hwang, research specialist, Department of Agricultural Economics, University of Minnesota.

cost of capital becomes the relevant figure to use. Cost of capital may be best measured by opportunity cost, especially where nonborrowed funds are used. If all funds are borrowed, the interest rate on borrowed money would likely be the cost of capital.

INVESTMENT DECISIONS

In using the net present value method to evaluate an investment decision, the financial manager needs to calculate two basic items. First is the net investment requirement for the proposal. The net investment requirement refers to the sum of all costs involved in making the investment, less any salvage value on equipment or buildings given up. For example, a particular capital item may require additional electric power, or an operation might have to be shut down for a few days. These expenses would be included in the project cost. On the other hand, the sale of the old asset is deductible from the purchase made. The net investment cost will be termed an outflow.

Second, one must consider the effect of the investment on the annual cash flow of the business. Annual cash revenues and cash outlays must be estimated to determine an annual net cash flow for each year of the project's expected economic lifetime. If borrowed funds are used to make the initial purchase, the cash outlay for repayment of the principal and interest must also be considered.

Estimating the net returns or net cash inflow is difficult because the focus is on *anticipated* revenues and *anticipated* costs. Product prices, wage rates, material costs, and other expenses are strongly influenced by external factors and thus are not easy to estimate closely. It is extremely important to make these projections, however, even if they are difficult to make. In the business world, it is becoming increasingly difficult to survive if management simply makes investments and hopes for the best, without doing good advance planning.

A firm contemplating an investment in an industry must take into account not only the probable trend in demand but also the trend in supply. The fertilizer industry presents a prime example: It had probably overexpanded by the late 1960's. It is very important for the management of a firm in an expanding industry to project the size of its market share. If, for example, the number of firms is increasing, can this firm expect to maintain its market share? At what price?

Once projections of net investment outlays and of the annual net cash flows have been made, it is possible to make an investment analysis.

APPLICATIONS OF NET PRESENT VALUE METHOD

The point was made earlier that there is a time value of money. A dollar in the hand today is worth more to most people than a dollar to be received sometime in the future. Likewise, the present value of a cost outlay in the future is less than for the outlay made today. Therefore, the financial manager must consider both the magnitude and timing of outflows and inflows in analyzing investment alternatives. Failure to do so may result in poor investment decisions. Some examples of investment analysis follow.

Alternative Flows of Income

Assume two alternative investment opportunities, each with a net cost of $4,000. Each will last three years and will return a total net revenue of $6,000. The firm's cost of capital is assumed to be 10 percent. The only difference is in the timing of the net annual income flows, shown in Table 3. Note that the original costs are designated in year 0 (representing the present) as negative amounts. By showing the outflows as negative amounts and the net inflows (annual revenue less annual expenditures) as positive values, it is possible to add and calculate directly the net present value of each investment. (Readers should practice finding example discount factors in Table 1.)

Disregarding risks and assuming no capital limitation, all projects showing a positive net present value would be undertaken — which in this case would be both A and B. But if only $4,000 is available, Project A with a net present value of $1,130 is clearly superior to Project B, which has a net present value of $814. The additional returns in Project A in the first year can be reinvested.

Permanent Versus Temporary Facility

Assume that a businessman has a choice of investing in a permanent asset facility with a life of 20 years for $16,000. Or, he could build a temporary facility with a life of five years for $5,000. Over a 20-year horizon, which investment should he make?

Assume a 10 percent cost of capital. Further, make the simplifying assumption that the annual net cash flows will be identical with the two approaches. In the preceding example, both costs and returns were considered; thus, the highest net present value showed the best investment. But in this example, returns are identical — only the costs vary. There-

Table 3. Hypothetical Investment Analysis for Two Projects With the Same Total Income over a Three-Year Period, Assuming a 10-Percent Cost of Capital

Year	Discount factor	Project A		Project B	
		Net cash flow	Present value	Net cash flow	Present value
0	1.0	−$4,000	−$4,000	−$4,000	−$4,000
1	.909	+ 3,000	+ 2,727	+ 1,000	+ 909
2	.826	+ 2,000	+ 1,652	+ 2,000	+ 1,652
3	.751	+ 1,000	+ 751	+ 3,000	+ 2,253
Net present value			$1,130		$ 814

fore, the alternative with the lowest present value of investment outlays will be best.

An initial outlay of $16,000 for the permanent asset facility would cover the 20-year horizon. Replacements would be required at 5-year intervals with the temporary facility to cover a 20-year horizon. Considering expected inflation, replacement costs are estimated at $6,000, $7,000, and $8,000. Thus the total outlay for the temporary facility would be $26,000, compared to $16,000 for the permanent facility.

However, the present value of each cost stream, calculated in Table 4, must be considered. Since the $16,000 is required at the *first* of the 20 years, the present value is also $16,000. But the present value of the initial and later outlays on the temporary facility is only $13,340. Other things being equal, the businessman should invest in the temporary facility.

Effects of Depreciation and Taxes

Suppose a grain company is debating whether to undertake fertilizer distribution, which will involve the construction of a $30,000 building. Assume that the building has an economic life of 10 years and that it will be depreciated on a straight-line basis at $3,000 each year. The effect of depreciation on net cash flow is introduced in this example. The net present value approach will be used, which requires determining the net investment cost. Next, the annual net cash flow is calculated, which in this case is a net cash inflow after taxes.

Assume the $30,000 building cost is the total net investment cost; that is, miscellaneous additional equipment needed for fertilizer distribution is included or already owned by the company. Further, assume the investment will have no salvage value at the end of 10 years.

Cash inflows will result from the sale of fertilizer. The prices and quantities of fertilizer to be sold must be estimated. To do so, management must take into account external factors such as the anticipated supply and demand for fertilizers. For this example, the cash inflow is

Table 4. A Present Value Analysis of the Initial Investment Outlays Required for Two Alternative Investments, Yielding Identical Revenues, Assuming a 10-Percent Cost of Capital

Year of investment	Permanent facility			Temporary facilities		
	Amount	Discount factor	Present value	Amount	Discount factor	Present value
0	$16,000	1.0	$16,000	$5,000	1.0	$ 5,000
5				6,000	.621	3,726
10				7,000	.386	2,702
15				8,000	.239	1,912
Present value			$16,000			$13,340

assumed to be $10,000 per year greater as a result of adding fertilizer distribution.

The $10,000 per year is not net, however. There are cash outflows for additional labor, raw materials, power costs, and miscellaneous expenses. Management estimates the sum of these annual cash outlays at $3,000 per year, in addition to the initial $30,000 outlay. Most of these costs would be associated with the fertilizer enterprise; but again, as in the case of cash inflows, these costs are supposed to be net costs that take into account changes in costs over the entire business as a result of the project.

The $10,000 minus $3,000 equals an annual before-tax flow of $7,000. Taxable income will equal cash inflow minus (cash outflow plus depreciation): $10,000 − ($3,000 + $3,000) = $4,000.

Calculation of the net present value of the investment is easy after making the cost and return estimates and determining the cost of capital to the firm (see Table 5). Recall that Table 2 factors are to be used when there is a series of equal annual payments or receipts — in this case, identical annual net after-tax cash flows. So with the factor 6.145 from Table 2, the net present value of the after-tax flow is calculated at $36,870. Subtracting the present value of the original investment cost leaves the project a net present value of $6,870. Disregarding risk and accuracy of the projected income and expenses and assuming no capital limitations, any project with a net present value above zero would be made.

Replacement Decisions

The present value approach is also useful in deciding when to replace capital equipment. Suppose a supply firm wants to determine how often to trade trucks. In this problem it will be necessary to consider repair and maintenance costs, reduced revenues due to breakdowns associated

Table 5. An Analysis of the Projected Net After-Tax Cash Flow, Discounted at 10 Percent, for a Fertilizer Distribution Investment by a Grain Company

Year	Estimated cash inflow	Estimated cash outflow	Net cash flow before taxes	Annual income tax[a]	Net after-tax cash flow	Discount factor at 10%	Present value
0	$ 0	−$30,000	−$30,000	$ 0	−$30,000	1.0	−$30,000
1-10[b]	10,000	− 3,000	7,000	− 1,000	6,000	6.145[b]	+ 36,870
Net present value							$ 6,870

[a] Taxable income × 25 percent. Taxable income equals cash inflow less the sum of cash expenses and depreciation.

[b] Since the net after-tax cash flow is constant at $6,000 for each of 10 years, a Table 2 discount factor can be used to discount all 10 years in one operation.

Table 6. Hypothetical Repair Costs, Reduced Revenues Due to Breakdowns, and Trade-in Value for a Truck (Eight-Year Period)

Year	Repairs and reduced revenue	Trade-in value
0	...	...
1	$ 200	$8,000
2	300	6,400
3	400	5,120
4	500	4,096
5	700	3,277
6	1,000	2,622
7	1,600	2,098
8	2,400	1,678

with an older truck, and the net cost of trading the truck. For purposes of illustration, tax considerations are ignored. Assumed repair costs and trade-in values are shown in Table 6. The analysis assumes that the firm starts with a new truck on hand.

Three alternatives are compared: A, trade every other year; B, trade every four years; C, trade every eight years. A 10-percent cost of capital, a new truck price of $10,000, and an eight-year planning horizon are used. The procedure will be to determine the present value of the combined cost stream plus reduced revenues for the eight-year period for each alternative. The alternative with the lowest present value would be the optimum strategy for the firm.

Calculations are summarized in Table 7. Actual outlays plus reduced revenues over the eight-year period are $16,400, $14,608, and $15,422, respectively, for alternatives A, B, and C. Items that remain constant for all alternatives do not need to be considered. If there were no regard for the time value of money, alternative B would be chosen. But by discounting the cost and reduced revenues for each alternative each year and summing the results, a different optimum strategy emerges. The present values for alternatives A, B, and C, are $10,465, $8,593, and $7,899, respectively. Since the lowest present value of the costs and reduced revenues is desired, alternative C would be optimum.

It is important to realize that the cost of capital was assumed to be 10 percent and that the analysis was made on a before-tax basis. Moreover, inflation might realistically alter projected cost figures for the truck replacement over time as well as affect estimates of costs and reduced revenues. Changes in any of these items could alter the outcome. Additional considerations might also be important — for example, the firm might want to avoid the frustrations that could be associated with driving an older truck or the adverse customer relations that might result from using older trucks. This example, however, is intended to illustrate a procedure that can be used in making replacement decisions.

Table 7. Costs Associated With Three Alternative Plans for Truck Replacement, Both Actual and Discounted

Year	Discount factor at 10 percent	Alternative A — trade every other year			
		Repair costs and reduced revenues	Net payout for new truck	Total cash outlay	P.V. of total cash outlay
0	...	$ 0	$ 0	$ 0	$ 0
1	.909	200	0	200	182
2	.826	300	3,600	3,900	3,221
3	.751	200	0	200	150
4	.683	300	3,600	3,900	2,664
5	.621	200	0	200	124
6	.564	300	3,600	3,900	2,200
7	.513	200	0	200	103
8	.467	300	3,600	3,900	1,821
				$16,400	$10,465
		Alternative B — trade every four years			
		Repair costs and reduced revenues	Net payout for new truck	Total cash outlay	P.V. of total cash outlay
0		$ 0	$ 0	$ 0	$ 0
1		200	0	200	182
2		300	0	300	248
3		400	0	400	300
4		500	5,904	6,404	4,374
5		200	0	200	124
6		300	0	300	169
7		400	0	400	205
8		500	5,904	6,404	2,991
				$14,608	$8,593
		Alternative C — trade every eight years			
		Repair costs and reduced revenues	Net payout for new truck	Total cash outlay	P.V. of total cash outlay
0		$ 0	$ 0	$ 0	$ 0
1		200	0	200	182
2		300	0	300	248
3		400	0	400	300
4		500	0	500	342
5		700	0	700	435
6		1,000	0	1,000	564
7		1,600	0	1,600	821
8		2,400	8,322	10,722	5,007
				$15,422	$7,899

INTERNAL RATE OF RETURN

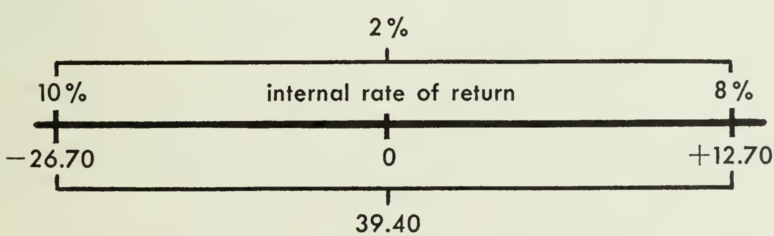
So far, only the net present value method of analysis has been applied. A closely related approach is the internal rate of return method. This method also utilizes a discounting of cash flows, but rather than assuming a cost of capital, it determines the rate of return that will equate the discounted sum of future earnings with net investment outlays for the project. The rate of return can be compared directly with the cost of capital. Only projects earning more than capital cost would be considered. This approach is also preferred for ranking various investment alternatives.

Assume an investment that costs $1,000 and will depreciate to zero in four years. If the net cash flow is $400 in year 1, $300 in year 2, $300 in year 3, and $200 in year 4, what rate of return is the project earning?

Determining this solution is unfortunately more cumbersome than, though similar to, the net present value approach. The procedure is to find what rate will discount the net cash flows to zero. A trial-and-error approach is used to locate two rates — one slightly too high and another slightly too low. With the true rate so bracketed, it can be interpolated from the other two.

Suppose a rate of return of 6 percent is first tried. Calculations in Table 8 show a net present value of $54.60. This indicates that the rate that will generate a net present value of zero is higher than 6 percent. Trying 8 percent yields a net present value of $12.70, indicating that the exact rate of return is still higher. At 10 percent, the net present value is −$26.70; therefore, the rate sought lies between 8 and 10 percent. To determine the precise rate of return,[1] we interpolate between 8 and 10 percent, as follows:

NPV at 8 percent = +12.70
NPV at 10 percent = −26.70



The internal rate of return of this investment is thus

$$8 \text{ percent} + \left(\frac{12.70}{39.40} \times 2\right) = 8.64 \text{ percent.}$$

[1] For a more detailed explanation of the process, see John A. Hopkin, Peter J. Barry, and C. B. Baker, *Financial Management in Agriculture,* pp. 207-210; The Interstate Printers and Publishers, Inc., Danville, Illinois, 1973.

Table 8. Trial-and-Error Method of Determining Discounted Rates of Return for a Hypothetical Example (Smith and Cooper, p. 58)

Year	Cash flow	6 percent		8 percent		10 percent	
		Discount factor	Present value	Discount factor	Present value	Discount factor	Present value
0	−$1,000	1.0	−$1,000	1.0	−$1,000	1.0	−$1,000
1	400	.943	+ 377.20	.926	+ 370.40	.909	+ 363.60
2	300	.890	+ 267.00	.857	+ 257.10	.826	+ 247.80
3	300	.840	+ 252.00	.794	+ 238.20	.751	+ 225.30
4	200	.792	+ 158.40	.735	+ 147.00	.683	+ 136.60
Net present value			+$ 54.60		+$ 12.70		−$ 26.70

When a single investment is being considered, the criterion for acceptance of the "internal rate of return" is that the rate of return should exceed the cost of capital. When several projects are being considered, the internal rate of return approach can be used to rank the desirabilities of the projects.

Ranking Proposals

Usually, firms have a number of capital projects, and management must decide which projects will be undertaken and in what order. Projects yielding the highest return on investment are normally made first, followed by other projects on which a return greater than the cost of capital is projected.

A list of hypothetical projects under consideration by a firm is given in Table 9. If the cost of capital were 9 percent and the firm could acquire or already had $112,000, it might conceivably undertake all 12 investment proposals. If the cost of capital were 14 percent, however, only the first nine projects would be undertaken, for a total investment of $88,000. Whether a project is undertaken depends not only upon its own rate of return as related to the cost of capital but also upon its rank in relation to other feasible alternatives.

There may well be situations with interdependencies among some of the projects ranked. Viewed independently, a given project might be dropped because of low returns. But other, higher return projects may be so related to the low-return project that dropping it would lower the overall returns to the firm.

Thus far, no difference in riskiness of returns has been considered. The projects in Table 9 were ranked with projected returns ranging from 25 percent to 10 percent. But the cost of capital might be higher for the riskier projects than for the less risky ventures. There is no general rule on how much risk a firm should take. Some managers possess more intuition and willingness to take on risky ventures than do others. The financial structure of the firm is also important — can

Table 9. Hypothetical Project Proposals Ranked by Returns on Investment (Smith and Cooper, p. 78)

Rank	Type of project	Rate of return (%)	Investment required	Cumulative investment
1	New	25	$25,000	$ 25,000
2	Replace	23	10,000	35,000
3	Replace	22	15,000	50,000
4	New	20	5,000	55,000
5	New	20	3,000	58,000
6	New	18	10,000	68,000
7	Replace	17	5,000	73,000
8	Replace	16	5,000	78,000
9	Replace	15	10,000	88,000
10	New	13	5,000	92,000
11	Replace	11	10,000	102,000
12	Replace	10	10,000	112,000

the firm withstand the shock of a loss? The interaction of managers, owners, and auditors should be involved in determining the limits of risk for the firm. A progressive manager will likely want some margin between the cost of capital and the projected rate of return on the projects undertaken; the question is, how much?

Effect of Investments on Working Capital

In the quest to expand operations a firm must watch the balance between capital investments and capital accumulation, especially if it has started out with an efficient working capital balance. A decision maker must be aware of the impact a capital project will have on working capital (the dollar difference between current assets and current liabilities). Working capital could be reduced to dangerously low levels in cases where the growth rate of capital investment outpaces the rate of equity capital accumulation to finance the investment. A firm in such a position is forced to shift working capital assets into capital projects.

In efforts to remain competitive or to take advantage of investment opportunities in high-return projects, it may be relatively easy for a firm to develop working capital shortages unless management remains alert about maintaining an efficient working capital balance. As investments increase, working capital must expand also.

Because of the possibility that sources of capital may be rationed in the short run, it is important for management to maintain a degree of flexibility in anticipating high-return capital investment opportunities. Differences in the rate of capital accumulation and in the rate of investment need to be considered. Maintaining flexibility and trying to avoid working capital shortages are likely to lead to greater profits for the firm in the long run.

Table 10. Balance Sheet for a Fertilizer Firm That Is Increasing Its Level of Net Fixed Investments by 10 Percent a Year While Increasing Its Long-Term Debt and Equity Levels by 5 Percent a Year

	Year				
	1	2	3	4	5
	(thousands of dollars)				
Current assets	400	380	356	328	294
Net fixed assets	600	660	726	798	878
Total assets	1,000	1,040	1,082	1,126	1,172
Current liabilities	200	200	200	200	200
Long-term debt plus equity capital	800	840	882	926	972
Total liabilities and equity	1,000	1,040	1,082	1,126	1,172
Net working capital (current assets minus current liabilities)	200	180	156	128	94

Based on Smith and Cooper, p. 79.

Table 10 provides an example in which the net fixed assets of a fertilizer firm were increased by 10 percent per year but the rate of capital accumulation did not keep pace. The effect was that working capital diminished from $200,000 in year 1 to $94,000 in year 5. Unless the trend is reversed, this firm will have increasing difficulty in meeting current obligations.

SUMMARY AND CONCLUSIONS

Most firms face decisions about long-term investments. Careful consideration needs to be given to projections of industry demand and supply and what share of the market a particular firm will be able to maintain over the life of the investment projects. In most cases the present value analysis of net returns and investment expenditures will provide the best information to decision makers about the advisability of investing in a particular proposal. Whether or not a project is undertaken depends not only upon its own rate of return but also upon its rank in relation to other feasible alternatives and to the cost of capital.

Consideration should also be given to the degree of risk involved and to the degree of capital accumulation in the firm. Moreover, one should recognize that since funds are often limited a firm may not want to invest up to the limit of its resources; for if it does, it can give up the flexibility needed to undertake a high-return project that may appear later. How much flexibility should be built in depends upon a number of factors, such as the rate of innovation, expenditures on research and development, and recent experiences with respect to returns on new projects.