Managing the Modern Farm Business: Agricultural Investment Analysis

Take AIM
The Annualized Incremental Method

Module 3
Advanced Investment Analysis

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and
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Faculty of Extension
University of Alberta

Special Funding from
Alberta Agriculture, Food
and Rural Development

Managing the Modern Farm Business
Agricultural Investment Analysis

Set - ISBN 1-55091-040-X
Module 1: Introduction to Investment Analysis - ISBN 1-55091-041-8
Module 2: Preparing Investment Data for Analysis - ISBN 1-55091-042-6
Module 3: Advanced Investment Analysis - ISBN 1-55091-043-4
Module 4: The Annualized Incremental Method - ISBN 1-55091-044-2
Module 5: Technical Appendix - ISBN 1-55091-045-0

Canadian Cataloguing in Publication Data
Bauer, Leonard, 1937 – 2004
Bushe, Donald, 1944 -

(Managing the modern farm business)
ISBN 1-55091-034-5 (set) ISBN 1-55091-035-3 (Module 1)

1. Agriculture – Economic aspects. 2. Farm investment. 3. Farm management.
I. University of Alberta, Faculty of Extension. II. Title. III. Series.
S561-B38 2003 630’.68 C03-910890-1

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PREFACE

Most of what I think I know about the basics of investment analysis and risk assessment I learned from my friend and mentor, Len Bauer. Len's work and teaching has influenced farm managers and their advisors around the world. I consider it an honour and a privilege to write a short forward for this series of modules on investment analysis.

So, why should managers be interested in this series of investment analysis modules? The answer is because the consequences of poor capital investment decisions can directly determine the financial viability of a business enterprise. One need look no further than the North American hog industry investment boom of the 1980's and 90's and watch the fallout occurring today to see a classic example of capital investment decisions gone wrong. The failure to apply sound management principles invites the market place to solve your management problems for you. The market plays no favorites, treating both big and small businesses the same.

These self-directed learning modules demonstrate the basic tools used in the business world today; they are the language and practice of modern business. My biases on the importance of having a strong understanding of management concepts come from over a decade spent as a researcher and instructor at the University of Alberta blended more recently by several years as manager of a commodity production business.

I have worked with many excellent business managers and if there is a central theme it is this: they distinguish themselves by their knowledge and ability to apply the basic principles of economic decision making and risk management. These modules outline the basic principles and give practical insights, through illustrations and exercises, on how the material can be applied in practical situations.

The following modules lay out the process of analyzing investment decisions. Although the discussion in the modules is restricted to simplified cases, the tools can be applied to any business enterprise. Even if a manager does not use the actual detailed methods in every situation (for example some of the tools contained in the technical appendix) there is power in understanding the proper process for collecting and analyzing the information required for making sound investment decisions. It is impossible to build sound strategies without a solid foundation.

I use these principles in my day to day operations. I strongly encourage managers and those who work with and advise managers in any capacity, to make use of Dr. Len Bauer's work. Today's managers must be able to master these methods and the instructional design provided by Don Bushe makes it easy for busy managers to assimilate the ideas efficiently.

Frank Novak, Managing Director

Alberta Pig Company

Analyzing Agricultural Investments

What is financial management? What constitutes investment in agriculture? What is it that financial managers do? There are at least three topics that financial managers must deal with: acquiring assets [making investments], financing assets [raising the funds to make the investment] and exerting financial control. Financial management and financial managers are needed in old established businesses, in thriving growing businesses and in businesses just starting up. They play important roles as businesses expand or retract. This financial management requires attention to three topics:

- First of all the financial manager must make asset acquisition decisions. Decisions must be made to determine whether a particular asset should be acquired; whether an investment should be made. This means that the manager must have confidence that the asset in question will contribute towards the financial goals of the owners.
- Secondly the financial manager must make financing decisions. Decisions must be made about how funds should be raised to acquire the asset. This decision comes second in the list of duties for a very important reason. The manager needs to ration his or her time. There is no purpose wondering about how to finance an asset that is not worthwhile in the first place.
- The final task for the financial manager is financial control. The financial situation must be monitored and corrective action taken whenever actual results differ from those desired. Control is a much simpler task if sound acquisition and financing decisions are made in the first place.

Purpose and Organization of these Modules

The purpose of this set of modules is to focus attention on the above financial management topics, acquisition, financing and control. It has been our observation that while the financing and control aspects have been well attended to by public and commercial advisory services we have been negligent, as a profession, in analyzing investment prospects. Accordingly this set of modules will concentrate mostly on budgeting techniques for making informed agricultural investment decisions.

There are five modules in the set.

Module 1 Introduction to Investment Analysis
The first is of an introductory nature. It examines the basic techniques, dismisses those that are inferior, namely urgency, payback period and accounting rate of return. The module then provides a comprehensive review of the tried and true systematic approach, net present value.

Module 2 Preparing Investment Data for Analysis
The second module deals with the advanced topics of discount rates, cash flow estimates, and inflation in preparation for calculating the net present value.

Module 3 Advanced Investment Analysis
The third module presents the topics of differential rates of inflation, risk, and income taxes within the net present value framework.

Module 4 The Annualized Incremental Method (a.k.a. The Partial Budget)
The fourth module covers the topic of partial budgeting. The point is made that the partial budget process is really an annualized net present value method.

Module 5 The Technical Appendix
The final module is a technical appendix organized much like a glossary of terms. Financial mathematics formulae and financial tables are an important part of this technical piece as are detailed explanations of issues thought too complex for the main modules.

Although some attention is paid in these modules to financing and control issues these topics are left to further development, for another time. As was pointed out good work has been done by the advisory professionals, government agents, bankers and accountants, and we refer the reader to those sources.

This Module

In this module, Advanced Investment Analysis, we work with investment data to examine more advanced issues surrounding the asset acquisition decision. It is worth stressing again that this is the starting place in financial management. Obviously, it is the first question to be asked and only if answered 'yes' should attention be given to finding the funds for making the investment. Just because one can borrow the money is insufficient reason for acquiring an asset. The asset must be worth more to the business than it costs to acquire it.

In determining whether a particular asset is worthwhile we must deal with a number of related issues.

- **Differential Rates of Inflation**, Each of the cash flows studied can inflate at different rates. for example, labour rates may differ from capital rates
- **Risk** cannot be ignored because the future is uncertain.
- **Income taxation** is a fact of life. Decisions must be made in an 'after tax' context.

Objectives

When you have completed your studies, you will be able to:

- Determine the appropriate discount rate for each situation
- Project the cash flows that represent the situation truly and fairly
- Estimate the effect of inflation under different scenarios
- Compensate for risk by adding a risk premium to the discount rate
- Build in the consideration for tax implications
- Verify the accuracy and appropriateness of the multi-year cash flows

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The Asset Acquisition Case

An opportunity exists for Rudy and Helga, owner managers of Rudy's Roots to replace seasonal labour with a mechanical root vegetable harvester. Both Rudy and Helga have professional backgrounds. Helga is an accountant employed by a local manufacturing company. Rudy has recently retired from his position as a high school math teacher; he is thus able to devote more of his time to managing Rudy's Roots. In this module attention is paid to advanced topics of inflation, taxes and risk.

Rudy and Helga, with the help of their friends at the local coffee hangout, Kathy's Kaffee Klatch, have learned much about analyzing their opportunity to acquire a root harvester to replace the piece-work labour they hire annually. However, the further they delved into the analysis process, they realized they had yet more to learn to create the foundation for a sound, unbiased decision.

Helga's expertise at the calculator was being thoroughly tested in developing cash flows accounting for the time value of money, inflation and the notion of risk. However, as she discussed her findings with Rudy and friends at the Kafee Klatch, she realized there were a few more elements that needed to be dealt with.

Firstly, the discounted cash flows she and Rudy had put together delivered a lump sum estimate of "net benefit" over the investment time line. Both she and Rudy feel more comfortable with "annual equivalents" as they are more intuitive in the context of their regular annual operating decisions. Helga noted that it would be beneficial to derive an "annual net present value" from her cash flows for comparison purposes.

The next item that her "Klatch Buddies" pointed out was that quite frequently, different cost items inflated over time at different rates. To be accurate in their evaluation, Rudy and Helga resolved to incorporate this element as well.

The last major item the Wurtzel's recognized as missing from their analysis was the effect of taxes on their results. Even though the basic cash flows defined the profitability of the investment, the notion of after-tax position could be significant.

Before setting out on the last piece of the analysis, Rudy and Helga agreed that, although there seemed to be a lot of work involved with just this one analysis, as they learned piece-by-piece with the concepts in hand, any subsequent analysis would be much more straight forward and less time consuming. During a private movement, Rudy confided with Helga that it certainly was fortunate that they kept decent records upon which they could base their analysis. Some of their Kafee Klatch peers seemed to be making significant business decisions based upon much less of their own "on-farm" information … particularly the Autruche's.

Annualized Net Present Values

Since net present value is expressed in real terms we must take care to use the real annuity factor instead of the nominal one. If we were to use the nominal annuity factor we would be over stating the annual equivalent value and possibly make a bad decision as a result. The correct procedure is to annualize the Net Present Values with the real amortization factor as shown in the table.

Real Cash Flows Discounted With Real Rates						
Time	Discount Factor	Capital	Repair	Maintenance	Labour	Total
0	1.0000	-50,000				-50,000
1	0.9375		-117	-5,516	14,063	8,429
2	0.8789		-132	-5,172	13,184	7,880
3	0.8240		-165	-4,848	12,360	7,347
4	0.7725		-212	-4,545	11,587	6,829
5	0.7242		-272	-4,261	10,863	6,330
6	0.6789		-339	-3,995	10,184	5,850
7	0.6365		-414	-3,745	9,548	5,389
8	0.5967		-492	-3,511	8,951	4,947
9	0.5594		-573	-3,292	8,391	4,526
10	0.5245	1,477	-656	-3,086	7,867	5,602
	real NPV	-48,523	-3,372	-41,971	106,996	13,130

It is important to remember that the discounted flows are in real terms when we calculate the annual equivalents; we must make sure to use the appropriate annuity factor. In converting the present value components to their annual equivalents we should use the real annuity.

Selected Amortization Factors		
Item	Nominal	Real
Discount Rate	12 %	6.67 %
10 year annuity factor	0.1769842	0.1401916
10 year annuity factor rounded	0.1770	0.1402

<u>Question</u>

Complete the missing calculations in the table. Then complete the statement.

Annualized Net Present Values					
Item	Capital	Repairs	Fuel & Maintenance	Labour	Total
real NPV	-48,523	-3,372	-41,971	106,996	13,130
real annuity factor		0.1402	0.1402	0.1402	0.1402
real ANPV	-6,803				1,841
nominal NPV	-48,523		-41,971	106,996	13,130
nominal annuity factor	0.1770	0.1770	0.1770	0.1770	0.1770
nominal ANPV	-8,588	-597			2,324
erroneous ANPV	-8,588	-597	-5,884	15,000	-69

If we use the real annuity factor we will have the entire situation remain in real terms. In the table above the annual equivalent of $13,130 is [$ ______], ($13,130 x 0.1402 = [$ ______]). Notice that the constant components of maintenance and labour savings appear respectively as -$5,884 and $15,000 which is as it should be. The annual net present value would be calculated correctly at $1,841, (6,803 – [______] – [______] + [$ ______] = 1,841).

Answer

Compare your work to the answers marked in bold. Correct any errors.

Annualized Net Present Values					
Item	Capital	Repairs	Fuel & Maintenance	Labour	Total
real NPV	-48,523	-3,372	-41,971	106,996	13,130
real annuity factor	**0.1402**	0.1402	0.1402	0.1402	0.1402
real ANPV	-6,803	**-473**	**-5,884**	**15,000**	1,841
nominal NPV	-48,523	**-3,372**	-41,971	106,996	13,130
nominal annuity factor	0.1770	0.1770	0.1770	0.1770	0.1770
nominal ANPV	-8,588	-597	**-7,428**	**18,937**	2,324
erroneous ANPV	-8,588	-597	-5,884	15,000	-69

If we use the real annuity factor we will have the entire situation remain in real terms. In the table above the annual equivalent of $13,130 is $**1,841**, [$13,130 x 0.1402 = $**1,841**]. Notice that the constant components of maintenance and labour savings appear respectively as -$5,884 and $15,000 which is as it should be. The annual net present value would be calculated correctly at $1,841, [6,803 **– 473 – 5,884** + **15,000** = 1,841].

If we used the nominal annuity factor the annual net present value would be $2,324, [$13,130 x 0.1770 = $2,324]. Even though the factor has been applied consistently to the components in the table conceptual problems might arise; unfortunately this annualized figure is difficult to interpret and introduces unneeded complexity into the analysis. It is a procedure best avoided and regarded as suspect.

When expressing present values as annual equivalents it is essential to use the real annuity factor. This makes interpretation easier, avoids serious procedural errors, and generally guards against bad decisions.

The major problem of using a nominal annuity factor arises because we might unwittingly apply it in an inconsistent manner. Suppose we use the nominal factor for the capital flows and repair components and obtain -$8,588 and -$579 for the respective components but then fall into the trap reasoning that fuel and maintenance and labour saving are a uniform series of -$5,884 and $15,000 over the ten years of analysis.

It is true. These are a uniform series in real terms, but are a growing series in nominal terms because of inflation; in nominal terms these are respectively -$7,428 (as opposed to -$5,884) and $18,937 (as opposed to $15,000) giving us an answer of -$69, [-$8,588 - $597 – 5,884 + 15,000 = -$69], (as opposed to the correct answer of $2,324 nominal). If we applied this erroneous procedure and reported an annual net present value of -$69 we would be misleading Rudy and Helga. Our advice would be to reject the investment when in fact it would have been a sound choice to acquire the harvester. Should Rudy's Roots accept our advice it would find out, as the future unfolded, that rising labour costs would cause losses.

Differential Rates of Inflation

Although the Consumer Price Index is the best measure for deflating the nominal discount rate to obtain the real rate, the cash flows components may inflate at different rates. Suppose we have determined that the capital flows, [the machinery investment itself], inflate at 4%, repairs and maintenance each inflate at 5% and labour at 6%. We want to include this additional information in our analysis. Inflation rates for different categories are available from such sources as Statistics Canada.

To get a feel for what nominal or market cash flows might look like over the next ten years, Helga multiplied the inflation factors by the real cash flows brought forward and presented in the "Real Cash Flows" table.

Differential Inflation Rates				
Time	Capital	Repair	Fuel & Maintenance	Labour
rate	0.04	0.05	0.05	0.06
0	1.0000	1.0000	1.0000	1.0000
1	1.0400	1.0500	1.0500	1.0600
2	1.0816	1.1025	1.1025	1.1236
3	1.1249	1.1576	1.1576	1.1910
4	1.1699	1.2155	1.2155	1.2625
5	1.2167	1.2763	1.2763	1.3382
6	1.2653	1.3401	1.3401	1.4185
7	1.3159	1.4071	1.4071	1.5036
8	1.3686	1.4775	1.4775	1.5938
9	1.4233	1.5513	1.5513	1.6895
10	1.4802	1.6289	1.6289	1.7908

The resulting nominal cash flow projections are found in the next table. Remember that these are obtained by multiplying the original real cash projection by the appropriate index. The initial capital outlay is made at time zero and so remains at -$50,000. The salvage value won't be obtained for 10 years and is expected to inflate at 4.00% per year. It accounts for the $4,168 nominal inflow of cash at that time.

Real Cash Flows					
Time	Capital	Repair	Maintenance	Labour	Total
0	-50,000				-50,000
1		-125	-5,884	15,000	8,991
2		-150	-5,884	15,000	8,966
3		-200	-5,884	15,000	8,916
4		-275	-5,884	15,000	8,841
5		-375	-5,884	15,000	8,741
6		-500	-5,884	15,000	8,616
7		-650	-5,884	15,000	8,466
8		-825	-5,884	15,000	8,291
9		-1,025	-5,884	15,000	8,091
10	2,816	-1,250	-5,884	15,000	10,682

Labour costs are expected to inflate at 6.00% per year. The base rate of $15,000 per year in real terms is expected to be 6.00% higher by the end of the first year, to a level of $15,900 for the year in nominal terms, [$15,000 x 1.06 = $15,900]. The remaining nominal cash flows are calculated in exactly the same manner as those described.

Question

Finish the calculations and place the results in the table. Then complete the statement.

Nominal Cash Flows (differential inflation rates)					
Time	Capital @4.00%	Repair @5.00%	Maintenance @5.00%	Labour @6.00%	Total
0	-50,000				-50,000
1			-6,178		9,591
2		-165	-6,487	16,854	10,201
3		-232	-6,811	17,865	10,822
4		-334	-7,152	18,937	11,451
5		-479	-7,510	20,073	12,085
6		-670	-7,885	21,278	12,723
7		-915	-8,279	22,554	13,360
8		-1,219	-8,693	23,908	13,995
9		-1,590	-9,128	25,342	14,624
10			-9,584	26,863	

Once Helga completed her calculations, she noted the nominal cash flow total for year ten was [______], compared to the real value of [_______].

Answer

Compare your work with Helga's calculations. Correct any errors.

Nominal Cash Flows (differential inflation rates)					
Time	Capital @4.00%	Repair @5.00%	Maintenance @5.00%	Labour @6.00%	Total
0	-50,000				-50,000
1		**-131**	-6,178	**15,900**	9,591
2		-165	-6,487	16,854	10,201
3		-232	-6,811	17,865	10,822
4		-334	-7,152	18,937	11,451
5		-479	-7,510	20,073	12,085
6		-670	-7,885	21,278	12,723
7		-915	-8,279	22,554	13,360
8		-1,219	-8,693	23,908	13,995
9		-1,590	-9,128	25,342	14,624
10	4,168	**-2,036**	-9,584	26,863	**19,411**

Once Helga completed her calculations, she noted the nominal cash flow total for year ten was [**19,411**], compared to the real value of [**10,682**].

The Discounting Process

We now move on to the discounting process. The nominal cash flows must be discounted by the nominal discount rate of 12% as is done in the following table. Recall that the nominal rate is composed of two components, the real rate and the rate of inflation, [1.12 = 1.0667 x 1.05].

Discounted Cash Flows (nominal flows, nominal discount rate)						
Time	Discount Factor @12%	Capital @4.00%	Repair @5.00%	Maintenance @5.00%	Labour @6.00%	Total
0	1.0000	-50,000				-50,000
1	0.8929		-117	-5,516	14,196	8,563
2	0.7972		-132	-5,172	13,436	8,133
3	0.7118		-165	-4,848	12,716	7,703
4	0.6355		-212	-4,545	12,035	7,277
5	0.5674		-272	-4,261	11,390	6,857
6	0.5066		-339	-3,995	10,780	6,446
7	0.4523		-414	-3,745	10,202	6,044
8	0.4039		-492	-3,511	9,656	5,653
9	0.3606		-573	-3,292	9,139	5,274
10	0.3220	1,342	-656	-3,086	8,649	6,250
	NPV	-48,658	-3,372	-41,971	112,200	18,198

Because of the process used and for reasons already explained the resulting present values are in real terms. Thus the Net Present Value, also real, is $18,198. The increase in net present value is attributable to the differential inflation expectations.

Because there is less inflation expected in the machinery investment stream, [4% as opposed to 5%], the capital costs will be slightly less than previously, [-$48,658 vs. $48,523]. Because the inflation expectation remains at 5% for repairs and maintenance these remain as before at -$3,372 and -$41,971 respectively. It is in the labour saving that the largest difference occurs. The 6% inflation rate expected for labour costs boosts the saving from a present value of $106,996 to $112,200. The net result is an increase from a NPV of $13,130 to $18,198 difference of about $5,000, [actually $18,198 – 13,130 = $5,068].

Annualized Net Present Value

The annual equivalent for the situation where different components are expected to inflate at different rates into the future is summarized below. It is important to remember that the Net Present Value of $18,198 is a real value. So, if we want to know the annual equivalent, we must amortize it with the real amortization factor at 6.67% over ten years.

After adjusting for inflation we conclude that Rudy's Roots would benefit from investment in the root vegetable harvester. The net present value is positive, [$18,198 in total or $1,2551 per year on an annualized basis], suggesting that the investment pays better than the real opportunity cost of 6.67%, (that is, better than a nominal rate of 12.0%).

The analysis is not yet complete. We have said nothing about risk to this point and neither have we considered income taxes. Both of these issues remain be addressed.

Remember, you can also use the Amortization formula.

$$A = \left[\frac{i(1+i)^n}{(1+i)^n - 1} \right]$$

Details are contained in the Technical Appendix, Module 5.

Annualized Net Present Values

Discount Factor	Capital	Repair	Fuel & Maintenance	Labour	Total
NPV	-48,658	-3,372	-41,971	112,200	18,198
Real annuity factor	0.1402	0.1402	0.1402	0.1402	0.1402
real ANPV	-6,821	-473	-5,884	15,729	2,551

Adjusting for Risk

To this point we have not dealt adequately with risk. As a matter of fact we have ignored risk in this investment to this point. We did mention that the 12% discount rate was based on a rate that would compensate Rudy's Roots for an investment in a well diversified common stock portfolio. We removed the 5.00% expected inflation from this rate and were left with a real opportunity cost of capital of 6.67%. But no direct reference was made to risk in this investment. We did spend some time making sure that the cash flows were expressed in terms of 'expected values.' Since the cash flows are in the form of expected values we should make sure that an adequate margin for risk is built into the discount rate. This margin is called the risk premium. It should relate to the degree of risk associated with the particular project.

Risk Adjusted Discount Rate

Rudy and Helga are of the opinion that this investment is twice as risky as an investment in a well diversified common stock portfolio. They formed this opinion after talking to the gang down at the Kaffee Klatch, a good cross section of farmers and business folks. The gang included Joe MacHinery, the equipment dealer, and Jim Argent the bank manager. They use this opinion to establish a 'risk premium.' Recall that the risk free rate was 7% and that the premium to attract investors to the common stock portfolio was 5 percentage points. Since, in their opinion they need twice the stock market premium to justify investment in the root vegetable harvester; they need 10 percentage points over the risk free government bond rate of 7%.

Question

Help Rudy and Helga determine the nominal risk adjusted discount rate by completing the calculations below. Refer to the information from Joe MacHinery and Jim Argent.

The nominal risk adjusted discount rate is hence 17%. Helga summarized the calculation below.

$$17.00\% = 7.00\% + 2 \times (\_\_.\_\_\% - 7.00\%)$$

So a risk adjusted nominal rate of return of 17.00% is needed. But what is this in real terms? With a 5.00% inflation rate the conversion is straight forward, as Helga was quick to point out; it's 11.43%. The calculation follows.

$$\frac{1.17}{\_.\_\_} - 1 = 0.1143 = 11.43\%$$

Answer

Compare your work to Helga's. Correct any errors.

The nominal risk adjusted discount rate is hence 17%. Helga summarized the calculation below.

17.00% = 7.00% + 2 X (**12.00%** - 7%)

So a risk adjusted nominal rate of return of 17.00% is needed. But what is this in real terms? With a 5.00% inflation rate the conversion is straight forward, as Helga was quick to point out; it's 11.43%. The calculation follows.

$$\frac{1.17}{1.05} - 1 = 0.1143 = 11.43\%$$

Expected Cash Flows

Earlier on Helga spent considerable time and effort researching the cash flows. Her first step was to obtain as much historical information as possible to establish an accurate picture of expected cash flows. Next she needed to convert these historical nominal components to their real counterparts. Now, since she expects differential rates of inflation of cash flow items, she needs to convert the flows to their nominal values. Her cash flow estimation work is reflected in the table below, previously noted as "Discounted Cash Flows (nominal flows, nominal discount rate).

Expected Nominal Cash Flows (@ differential inflation rates)					
Time	Capital @4.00%	Repair @5.00%	Fuel & Maintenance @5.00%	Labour @6.00%	Total
0	-50,000				-50,000
1		-131	-6,178	15,900	9,591
2		-165	-6,487	16,854	10,201
3		-232	-6,811	17,865	10,822
4		-334	-7,152	18,937	11,451
5		-479	-7,510	20,073	12,085
6		-670	-7,885	21,278	12,723
7		-915	-8,279	22,554	13,360
8		-1,219	-8,693	23,908	13,995
9		-1,590	-9,128	25,342	14,624
10	4,168	-2,036	-9,584	26,863	19,411

Now that Helga has both the discount rate and the expected cash flows available she can continue with the discounting process. The cash flows are in nominal terms; in what form must the discount rate be, nominal or real? Helga knew the rule; nominal discount rates go with nominal cash flows, real with real.

Net Present Value

Helga proceeded in calculating the present value of the cash flows using the nominal risk adjusted discount rate of 17% on the nominal cash flows. She simply multiplied the appropriate cash flow item from the table of nominal cash flows above by the correct discount factor and placed the result in the table below.

Nominal Expected Cash Flows Discounted with Nominal Risk Adjusted Discount Rate						
Time	**Discount Factor @17**	**Capital**	**Repair**	**Maintenance**	**Labour**	**Total**
0	1.0000	-50,000				-50,000
1	0.8547		-112	-5,281	13,590	8,197
2	0.7305		-121	-4,739	12,312	7,452
3	0.6244		-145	-4,253	11,155	6,757
4	0.5337		-178	-3,817	10,106	6,111
5	0.4561		-218	-3,425	9,156	5,512
6	0.3898		-261	-3,074	8,295	4,960
7	0.3332		-305	-2,759	7,515	4,452
8	0.2848		-347	-2,476	6,808	3,986
9	0.2434		-387	-2,222	6,168	3,560
10	0.2080	867	-424	-1,994	5,588	4,038
	NPV	-49,133	-2,498	-34,038	90,693	5,024

Upon completing the calculations she found the net present value to be $5,024. What should the decision be? The decision rule says accept those investments that have a net present value greater than zero.

A net present value of zero would mean that Rudy's Roots would save enough in labour bills to cover all of the costs associated with the root vegetable harvester including an opportunity cost of 17% on the money tied up in the machine; a negative net present value means they will not cover the costs.

Decision Rule: Choose only those investments with an expected net present value of zero or greater.

Annualized Net Present Value

As a further point of refinement Rudy converted the net present value components to their annual equivalents. Since the net present value components are automatically in real terms he set out to calculate the appropriate real annuity factor.

Question

Help Rudy to calculate the real annuity factor, then complete the statement.

Rudy used the formula:

$$A = \left[\frac{i(1+i)^n}{(1+i)^n - 1} \right]$$

noting that the discount rate, *i*, was the real, adjusted discount rate of [______], solving for year 10 as *n*. After crunching through the calculations he came up with a real annuity factor of [______]. He was ready to use it to make the conversions.

Answer
Compare your work to Rudy's. Correct any errors.

Rudy used the formula,

$A = \left[\frac{i(1+i)^n}{(1+i)^n - 1} \right]$ noting that the discount rate, *i*, was the real, adjusted discount rate of [**0.1143**], solving for year 10 as *n*. After crunching through the calculations he came up with a real annuity factor of [**0.1729**] and used it to make the conversions.

Annualized Net Present Value					
Discount Factor @17	Capital	Repair	Maintenance	Labour	Total
NPV	-49,133	-2,498	-34,038	90,693	5,024
real annuity factor	0.1729	0.1729	0.1729	0.1729	0.1729
real ANPV	-8,493	-432	-5,884	15,678	868

On an annual basis Rudy's Roots would be $868 ahead by investing in the root vegetable harvester. It looks like a good investment; go for it!

Adjusting for Tax

One final issue remains. So far we have avoided the matter of income tax; in reality an investor is interested in the after tax net present value; we must therefore make this last adjustment to the analysis.

After Tax Discount Rate

If Rudy and Helga earned income on investments at a certain rate it would have to pay a part of that in income taxes; recall that Rudy's Roots in a sole proprietorship operated by Rudy and Helga. When Rudy and Helga adjusted their discount rate to allow for the inherent risk in the investment they included a risk premium of 5% above the stock market rate. The risk adjusted nominal rate was 17%, which is 11.43% in real terms when the rate of inflation is 5%, [1.17 / 1.05 – 1 = 0.1143 = 11.43%]. Rudy and Helga operate under the 36.00% marginal rate of taxation thus each additional dollar of profit earned is taxed at the 36.00% rate. Rudy's Roots retains 64.00% of what it earns resulting in an after tax rate of 7.31% [11.43% x .64 = 7.31%]. Remember this is now the real, risk adjusted, after tax discount rate.

After Tax Cash Flows

As was the case with the discount rate, cash flows must also reflect the after tax situation. Converting the operating cash flows to their after tax state is rather straight forward; we just reduce them by the marginal tax rate. The capital investment cash flows are a bit more involved.

Rudy and Helga begin with the real pre-tax cash flow data as shown below in the table entitled as the Real Pre-Tax Cash Flows. They anticipate that there will be continued inflation in the economy. The earlier assumption of differential inflation rates among the various categories remains as reasonable. The table below, entitled "Expected Nominal Cash Flows (@ differential inflation rates)" takes them back to the starting point where inflation was accounted for and they were about to bring in risk.

Expected Nominal Cash Flows (@ differential inflation rates)					
Time	Capital @4.00%	Repair @5.00%	Fuel & Maintenance @5.00%	Labour @6.00%	Total
0	-50,000				-50,000
1		-131	-6,178	15,900	9,591
2		-165	-6,487	16,854	10,201
3		-232	-6,811	17,865	10,822
4		-334	-7,152	18,937	11,451
5		-479	-7,510	20,073	12,085
6		-670	-7,885	21,278	12,723
7		-915	-8,279	22,554	13,360
8		-1,219	-8,693	23,908	13,995
9		-1,590	-9,128	25,342	14,624
10	4,168	-2,036	-9,584	26,863	19,411

To complete the preparatory tasks Helga suggested they convert things back into real terms. "Right on", Rudy agreed. She proceeded to deflate the nominal amounts by the Consumer Price Index to bring things to the common denominator. "The CPI is taken to be 5.00% in this case," Helga continued. To illustrate the procedure Helga found the real labour saving in the first year to be $15,143 which she obtained by deflating the nominal $15,900, [15,900 / 1.05 = 15,143].

Real Pre-Tax Cash Flows (adjusted by differential inflation rates and the Consumer Price Index)					
Time	Capital	Repair	Fuel & Maintenance	Labour	Total
0	-50,000				-50,000
1		-125	-5,884	15,143	9,134
2		-150	-5,884	15,287	9,253
3		-200	-5,884	15,433	9,349
4		-275	-5,884	15,580	9,421
5		-375	-5,884	15,728	9,469
6		-500	-5,884	15,878	9,494
7		-650	-5,884	16,029	9,495
8		-825	-5,884	16,182	9,473
9		-1,025	-5,884	16,336	9,427
10	2,559	-1,250	-5,884	16,491	11,916

Hey, just a minute," Rudy wanted to know, "Why are we doing this anyway?" "Doing what? Helga asked." "Converting back to real and using the CPI?" was Rudy's response.

"Well, we used three different rates of inflation, [4%, 5% and 6%]. The most appropriate rate of inflation generally in the economy is the rate reflected in the CPI, after all we eventually intend to consume our earnings and the CPI is the best measure of 'economic erosion' that consumers experience." "Wow, have you been over at the Klatch listening to Phil Hautparleur?" "Ha! ha!"

After tax operating cash flows

Operating cash flows appear directly on the profit and loss statement as far as income taxes are concerned. Consequently, when an expense is incurred, it can be written off as a tax expense. When $100.00 is spent on repairs $36.00 will be recovered through income tax savings. The net effect, [the after tax effect], of the expense is therefore only $64.00, [$100 x (1 – 0.36) = $64].

Real After-Tax Operating Cash Flows					
Time	Capital	Repair	Fuel & Maintenance	Labour	Total
0	-36,022				-36,022
1		-80	-3,766	9,691	5,846
2		-96	-3,766	9,784	5,922
3		-128	-3,766	9,877	5,983
4		-176	-3,766	9,971	6,029
5		-240	-3,766	10,066	6,060
6		-320	-3,766	10,162	6,076
7		-416	-3,766	10,259	6,077
8		-528	-3,766	10,356	6,063
9		-656	-3,766	10,455	6,033
10	1,844	-800	-3,766	10,554	7,832

"Do you want to finish the after tax cash flow calculations or do you want to prepare supper," Helga gave Rudy the options. Rudy chose to transform the pre-tax to their after-tax counterparts. To illustrate, $125 in pre-tax cost is $80 in after-tax when there is a 36% marginal rate of income tax, [125 x (1 – 0.36) = 80].

After tax capital cash flows

Capital flows are a bit more involved. Investment in depreciable assets allows the investor to write the asset off as an expense for tax purposes over some designated period of time by claiming capital cost allowance (CCA); CCA is the tax department's fancy way of saying depreciation. While depreciation is not a cash flow the resulting tax benefits are. We need to adjust the capital flows to an after tax basis. We do this by realizing that when we acquire an asset we are also acquiring a stream of tax benefits; the finance folks call this building a 'tax shield.'

We could calculate the tax shield for each year into the future or we could trust the tax shield formula to do this for us. Let's trust the formula.

The formula, shown below, calculates the present value of the stream of future tax savings. In the formula, "PV_F", represents the present value factor which tells us the future saving received for each dollar invested in a depreciable asset, "d" is the Capital Cost Allowance or rate of depreciation, "t" is the marginal rate of taxation and "i" the after tax discount rate.

$$PV_F = d\,\frac{t}{d+i}\left[\frac{1+0.5i}{1+i}\right]$$

Rudy's Roots is contemplating an investment of $50,000 into a root vegetable harvester. This self propelled machine falls into Tax Class 10, which means it can be depreciated at 30% per year according to Canadian Tax Regulations. Since Rudy's Roots is an unincorporated business Rudy and Helga file personal tax returns. With judicious tax strategies they find themselves in the marginal tax range of 36%. This is to say that each extra dollar earned will attract 36% in income taxes. The real, after tax risk adjusted discount rate has been established as 7.31%.

$$PV_F = 0.30\,\frac{0.36}{0.30+0.0731}\left[\frac{1+0.5x0.0731}{1+0.0731}\right] = 0.2796$$

The present value factor for this set of conditions is 0.2796 which means that for each dollar invested $.2796 is recovered in future tax savings. Stated another way the net outlay for one dollar's worth of investment is $.7204, [1.0000 – 0.2796 = 0.7204].

Real After-Tax Capital Cash Flows					
Time	Capital	Repair	Fuel & Maintenance	Labour	Total
0	-36,022				-36,022
1		-80	-3,766	9,691	5,846
2		-96	-3,766	9,784	5,922
3		-128	-3,766	9,877	5,983
4		-176	-3,766	9,971	6,029
5		-240	-3,766	10,066	6,060
6		-320	-3,766	10,162	6,076
7		-416	-3,766	10,259	6,077
8		-528	-3,766	10,356	6,063
9		-656	-3,766	10,455	6,033
10	1,844	-800	-3,766	10,554	7,832

In the case of Rudy's Roots an investment of $50,000 would have $13,978 worth of tax savings associated with it in present value terms over an infinite lifetime, [$50,000 x 0.2796 = $13,978]. Alternatively the net after tax value of this piece of equipment would be $36,022, [$50,000 – $13,978 = $36,022].

Rudy felt he'd accomplished something here and had finished looking after the capital flows. Helga quickly disagreed. "I think you've forgotten something, dear. When we sell off the asset at the end of its useful life, doesn't that 'stream of tax benefits' end?"

Rudy scratched his chin. Whatever, did she mean?

Helga stepped through her thinking. "The net value of $36,022 assumes that the harvester will be kept in perpetuity, that is, forever. Of course we're free to dispose of this equipment in due course for whatever market price pertains at the time."

"You've estimated that the harvester will have a real market value of $2,559; in nominal dollars we will receive $4,168 but that will only buy what $2,559 will buy in today's money. Of course, these are only our expectations; reality might well be different."

<u>*Question*</u>

Help Helga show Rudy what he has missed out by completing the calculations and filling the blanks in the following statement.

"The important point is that selling the used, ten year old, root vegetable harvester will terminate the stream of tax savings; remember the present value of [$ ______] assumes that the machine is kept forever. So, after ten years the stream of tax savings stops. This means we must deduct the unused savings which disappear with the sale of the used machine. How much is this? Well, $2,559 has a net value of [$ ______], ($2,559 x 0.7204 = [$ ______]). In other words we have to give up $715 in future tax savings because of the sale, ([$ ______] x [______] = $715)."

Answer

Compare your work to Helga's. Correct any errors.

"The important point is that selling the used, ten year old, root vegetable harvester will terminate the stream of tax savings; remember the present value of $**36,022** assumes that the machine is kept forever. So, after ten years the stream of tax savings stops. This means we must deduct the unused savings which disappear with the sale of the used machine. How much is this? Well, $2,559 has a net value of $**1,844**, [$2,559 x 0.7204 = $**1,844**]. In other words we have to give up $715 in future tax savings because of the sale, [$**2,559** x **0.2796** = $715]."

Making the Decision

Rudy and Helga now have all of the information needed to prepare the after-tax cash flow statement for both the capital and operating components. Helga made special note that the cash flow items were in real terms.

Helga knew she had a bit of work yet to do. For instance, the capital flow adjusted for the tax shield in her previous work came to a net value of $1,844 but this is ten years away, so must be discounted back to the present. The present value of the $1,844 net amount recovered for the used root vegetable harvester is $910, [$1,844 x 0.4937]; 0.4937 is the discount factor at 7.31% over 10 years. Helga proceeded to calculate the net present value of the cash flows in the usual way, using the risk adjusted, real after tax rate as a basis.

Real, After Tax, Risk Adjusted Net Present Value (Operating and Capital Components)						
Time	Discount Factor @ 7.31 %	Capital	Repair	Fuel & Maintenance	Labour	Total
0	1.0000	-36,022				-36,022
1	0.9318		-75	-3,509	9,031	5,447
2	0.8683		-83	-3,270	8,496	5,142
3	0.8091		-104	-3,047	7,992	4,841
4	0.7540		-133	-2,839	7,518	4,546
5	0.7026		-169	-2,646	7,072	4,258
6	0.6547		-210	-2,466	6,653	3,978
7	0.6101		-254	-2,297	6,259	3,707
8	0.5685		-300	-2,141	5,888	3,447
9	0.5298		-348	-1,995	5,539	3,196
10	0.4937	910	-395	-1,859	5,210	3,866
	NPV	-35,111	-2,069	-26,069	69,657	6,408
	real ANPV	-5,072	-299	-3,766	10,062	926

Using the risk adjusted real after tax discount rate of 7.31% Helga determined the Net Present Value to be $6,408. On an annualized basis this amounts to $926.

Decision Rule: Choose only those investments with an expected net present value of zero or greater.

Rudy and Helga are now in a position to decide on the question. Should Rudy's Roots invest in the root vegetable harvester? Would it be a wise investment from a profitability point of view? Unless there are extenuating circumstances the investment appears sound.

Conclusion

This module builds on two earlier modules, namely Agricultural Investments and Partial Budgets. Four advanced topics were considered beyond the scope of these introductory modules.

First we stressed the amount of attention that needs to be paid to obtain good, practically derived estimates of the discount rate and the cash flows. Good information is the basis of sound decisions.

Next we explored the issues of inflation. Because different components of the investment situation may inflate at different rates we needed to allow for differential rates of inflation. We noted especially that the analysis remains consistent throughout, i.e. we must use nominal discount rates with nominal cash flows and we must use real discount rates with real cash flows. It is also important to recognize whether the rates and flows are real or nominal and we must keep them pure.

Risk was the next element to be discussed; risk is such an important component in investments so we devoted requiring much of our attention. Our approach was to take care in estimating the expected cash flows and then incorporating a risk premium into the discount rate.

We needed to cover income taxes and the required modifications to the analysis. Since investors are primarily interested in after-tax performance we needed to make adjustments to both the discount rate and to the cash flows. Capital cash flows presented a particular challenge.

Finally the decision had to be made. The issues of inflation, risk and taxation were carried forward so that the final decision took all of these components into account.

About the Authors

Leonard Bauer

Len Bauer joined the University of Alberta in 1977 to assume research and teaching duties in agricultural business management, finance, and production economics. He was instrumental in creating the Agricultural Business Management Program at the University and was its first director.

He was guest professor at the University of Hohenheim in West Germany and guest lecturer at FINAFRICA in Milan, Italy, and at Curtin University of Technology in Perth, Australia. In 1995 he was workshop leader for agricultural economics instructors in Ukraine.

After retiring in 1996, Len continued developing instructional materials in Agricultural Business Management. Len, the Professor Emeritus of Agricultural Business Management in the Department of Rural Economy was dedicated to stamping out ignorance – wherever it was found. This set 'Agricultural Investment Analysis' was virtually complete prior to his death in 2004.

Don Bushe

Don Bushe is a consultant, writer, teacher, and designer of interactive instructional materials. His products and publications have received recognition from the European Broadcasting Union, Ohio State Awards of Excellence, National Educational Broadcasters' Association, and the Japan Prize. Pipeline operators from Rio de Janeiro to Norman Wells have benefited from the training curriculum he analyzed and designed. His interactive DVD display systems operate in museums from the Royal Tyrrell to Arviat in Nunavut. He is most proud of his role in assisting college instructors and university faculty in Ukraine as they struggled to re-define their economics curriculum in the post-soviet era.

Don and Len have developed a number of self-instruction modules in farm management for the University of Alberta, Faculty of Extension. Together, they prepared what has become the standard textbook for agricultural economics in Ukraine. Their work has been reviewed and checked by Len's colleagues and former students.

About the Collaborating Reviewers

Ted Darling

Ted Darling has been with Alberta Agriculture, Food and Rural Development since the mid-1970's, first as District Agriculturist and later as Farm Management Specialist. In 1990 he returned to the U of A for a Masters degree in Ag. Economics and he is currently an Agricultural Risk Specialist for the department based in Airdrie. Ted's interests lie in the area of individual firm management, and include risk, strategic planning, and innovative business arrangements.

Dean Dyck

Dean is the Financial Business Analyst - New Ventures with Alberta Agriculture, Food and Rural Development. Dean graduated with a Bachelor of Science in Agriculture in 1982 from the University of Saskatchewan with a major in Agricultural Economics. He has over 20 years of experience in farm business management, including positions as a Production Economist and Farm Management Agrologist with Saskatchewan Agriculture, and Farm Management Specialist with Alberta Agriculture. Dean's main interest is in financial, economic and risk analysis and production costs for new agricultural ventures.

Dale A. Kaliel

Dale's life is firmly rooted in agriculture. Hearkening from a mixed farm in northern Alberta, Dale received his B.Sc. Agric. (Animal Science) in 1977 followed by a M. Sc. Agric. (Ag. Econ.) in 1982 under the tutelage of Dr. Len Bauer. He has worked with Alberta Agriculture, Food and Rural Development in a number of capacities since 1980 advancing to his current position of Sr. Economist: Production Economics.

The focus of Dale's career has revolved around creating economics, financial and business management information for Alberta producers and then striving to take them to the next, critical step ... showing them how to utilize their own "on-farm" information, applying fundamental economics principles and procedures, to make better business management decisions.

Frank Novak

Born and raised in Southern Alberta, Frank obtained his B. Sc. in Ag, and M. Sc. in Ag. Economics from the University of Alberta. Len Bauer was his advisor and mentor who urged him to continue to complete his Ph. D. in Ag. Econ. at the University of Illinois specializing in agricultural finance, farm management, and risk management. Frank taught at the U of A's Department of Rural Economy from 1989 to 1999. He was a founding partner of Alberta Pig Company in 1995 and left the U of A to work full time in the industry in 1999. He is currently the managing director of Alberta Pig Company.

Brian Radke

Following graduation from the Western College of Veterinary Medicine in 1989, Brian practiced large animal medicine for 5 years, first in Ontario and then in BC's Fraser Valley. He completed a Ph.D. in Agricultural Economics at Michigan State University in 1998. Brian is currently a Research Economist in the Economics and Competitiveness Division of Alberta Agriculture, Food and Rural Development, and previously held the position of Dairy Cattle Research Veterinarian with the Animal Industry Division. He is also an Adjunct Professor in the Department of Rural Economy, University of Alberta.