Advanced income property appraisal

William Shenkel*

Real estate valuation techniques have undergone significant changes over the last ten years. These changes have largely developed as personal computers became more widely available. Their increasing calculation speed and their greater memories have resulted in *new appraisal computer programs.* The rising sophistication of investors further encourages revised valuation practices.

The more significant changes fall in three main categories: (1) *Cash flow models,* (2) *statistical forecasting* and (3) *artificial intelligence.* Before dealing with these topics, it is deemed worthwhile to review the more popular options open to appraisers valuing income property.

1. *Appraisal options*

First, there is the question of the duration of annual income. Is the income to be capitalized in perpetuity, as we normally capitalize land rent, or should income be capitalized over a limited time? If a limited time is selected, what is the duration of the expected income?

Secondly, consider the various methods to value income property. In North America, income appraisers will usually follow some variation of five valution models:

— Direct capitalization (capitalization in perpetuity)
— Residual capitalization
— Before tax cash flow
— After tax cash flow
— Multiple regression analysis.

* Professor, Department of Legal Studies, Insurance and Real Estate, College of Business Administration, University of Georgia, Athens, GA 30602, USA.

Direct Capitalization

In the first instance, direct capitalization requires only three variables: *gross income, operating expenses*, and the *capitalization rate*. It is assumed that income prevails in perpetuity under the formula:

$$MV = NOI/R$$

Where MV = Market value
NOI = Net operating income
R = Capitalization rate

Thus MV = \$1,000,000/.08
= \$12,500,000.

Residual Capitalization Techniques

The residual techniques treat land and building separately. It is reasoned that land does not depreciate and that capital recovery is incorporated in the capitalization rate applied to land improvements as follows:

$$MV = ((NOI - (LV)\ (R))/(R + CR)) + LV$$

Where

LV = Land value
CR = Capital recovery (the reciprocal of the annual building life)

For example, assume:

LV = \$1,000,000
R = .08
D = .04
NOI = \$10,000,000

To solve this equation, land value must be given. If the building has an estimated economic life of 25 years, market value would the equal

$$MV = ((\$10{,}000{,}000{,}000 - (\$1{,}000{,}000)(.08)) / (.08+.04)) + \$1{,}000{,}000$$
$$= \$9{,}200{,}000 / (1.12) + \$1{,}000{,}000$$
$$= \$77{,}666{,}667$$

The present value factor (PVF) could be substituted for the eight percent capitalization rate and the present value of an annuity factor (PVAF) substituted for (R + D). This latter calculation would give market value for income received over a limited period.

Before Tax Cash Flow

The before and after tax flow models substitute for the more simplified residual valuation techniques. The before tax cash flow model discounts annual net operating income after mortgage paymentns and discounts an assumed sale price less the remaining mortgage balance realized at the end of a projected investment period.

Expressed in symbolic form, the formula is

$$MV = M + \sum_{t=1}^{n} \left[\frac{NOI_1[1+G(t-1)] - Mf}{(1 + Y)^t} \right] + \frac{(1 - dep)\ V - (1 - P)\ M}{(1 + Y)^n}$$

Where
- M = Mortgage
- N = Holding period
- G = Annual growth rate
- f = Mortgage constant (Installment of one times 12)
- Y = Yield on equity
- MV = Market value
- dep = Depreciation
- P = Mortgage payments
- V = Total value of property

Some seven variables are required for this routine. To illustrate assume the following variables (if the appreciation is expected, substitute (1 + app) for (1 - dep.).

Net operating income	: $10,000,000
Mortgage term	: 15 years
Mortgage interest	: 10 percent
Mortgage principal	: $50,000,000
Yield on equity	: 15 percent
Expected holding period	: 10 years
Projected sale price	: $150,000,000

The underlying assumptions of this technique turns on the propositions that investors invest over a relatively short term (e.g., 10 years or so), that the return on capital is measured after mortgage payments, that investment property is financed, and that capital appreciation (or depreciation) is considered in making investment decision.

Under the above formula and assumptions, before cash flow may be calculated as follows:

1. *Present value of annual before tax cash flow*
   Net operating income .... $ 10,000,000
   Less annual mortgage requirement .... $ 6,145,000
   (10%, 180 months, $50,000,00 × 1290)
   Annual income to equity .... $ 3,855,000
   Present value of annual before tax cash flow
   $ 3,855,00 × 5.0188 (Present value of an annuity) .... $ 19,347,474

2. *Present value of sales proceeds*
   Sales price $150,000,000
   Less mortgage balance .... $ 24,628,479
   Sales proceeds $125,371,521
   $125,371,521 × 247185 .... $ 30,984,944
   (Present value of one, 10 years, 15%)

3. *Estimated market value*
   Value of annual before tax cash flow .... $ 19,347,474
   Value of sales proceeds .... $ 30,984,944
   Value of equity interest .... $ 50,332,418
   Add original mortgage .... $ 50,000,000
   Property value to realize a 15% yield $100,332,418

Given the value of the equity interest, $ 50,322,418, and the assumed mortgage, the investor will earn a yield of 15 percent if these assumptions are realized. In short the property assumes value according to the present value of before tax cash flow and expected sales proceeds.

After Tax Cash Flow Models

After tax cash flow models follow the same reasoning with the added variables of (1) annual income taxes and (2) capital gain taxes at the end of the expected holding period. Only income *after tax* is capitalized under this model. This model is based on the formula:

$$DATCF = \sum_{t=1}^{n} \frac{CF_t}{(1 + i)^t} + \frac{NSP - MB - CGT}{(1 + i)^n}$$

Where

DTACF	=	Discounted after-tax cash flow
CF_t	=	Annual cash flow over projection period t
NSP	=	Net sales price (a projection)
MB	=	Mortgage balance
CGT	=	Capital gains tax
i	=	Discount rate
n	=	holding period

To illustrate a computer model for this problem, consider the assumption of Table 1. While the data relate to the United States tax law, with adaptation to local regulations, the model as listed in Table 1 would be equally valid in other jurisdictions.

TAB. 1. Date for after tax discounted cash flow model

Mortgage principal	$	75,000,000
Mortgage interest rate		12%
Mortgage term (months)		240
Building value	$	100,000,000
Building life (years)		27,5
Effective gross income	$	28,000,000
Annual operating expense	$	8,000,000
Percentage increase in income		O
Personal income tax rate		28%
Holding period in years		5
Annual discount rate		15%
Original cost	$	150,000,000
Projected selling price	$	200,000,000

The building life of 27.5 years is a legal requirement in the United States and determines the depreciation expense deduction for income taxes. Table 2 shows the calculation of the after tax cash flow over five years. Note that the model shows the after tax cash flow which equals net income less annual mortgage payments and less annual income taxes.

Next calculate the after tax sales proceeds which equals the sales price less the capital gain tax and less the remaining mortgage balance, while the model relates to United States experience, the central rationale here is that the investor acquires the right to the present value of annual discounted after tax cash flow, and the discounted value of projected sales proceeds. Hence given the assumptions of this illustration, the present value of after tax cash flow, $ 82,375,751, exceeds the initial investment of $ 75,000,000. These fata are summarized in Table 3. To test the feasibility of this investment appraisers use computer-calculated financial ratios.

Table 4 illustrates a set of fairly common ratios to evaluate the investment and the accurancy of the appraisal. The rations meet the preferred test for most investments; namely, the debt coverage ratio is quite favorable, is exceeds the minimum of 125 percent. The loan to value ratio falls within acceptable limits, 50 percent; the net present value, which is the difference between discounted after tax cash flow and the equity, is positive; and the profitability index is greater than one. The break-even point indicates that the $ 28,000,000 gross income may decrease some 36 percent and still cover annual debt service and operating expenses. The net operating ratio of 71.4 percent agrees with local experience and shows that the net operating income and its operating expenses is fairly typical. The return on equity, 26.67 percent, and the internal rate of return fall within very favorable and acceptable limits.

Multiple Regression

Historically multiple regression models have been restricted to single family dwellings and vacant land. However, with an income property database, multiple regression techniques have important appraisal applications. Multiple regression technique assume that there is a relationship between a change in market value and a change in property characteristics.

In the case of income property, it is reasoned that property assumes value according to its net operating income. Net operating income, in turn, is related to selected property characteristics. If this proposition follows, then income property may be valued directly

Tab. 2. Discounted after tax cash flow

	Year 1	Year 2	Year 3	Year 4	Year 5
Net operating income	$ 20,000,000	$ 20,000,000	$ 20,000,000	$ 20,000,000	$ 20,000,000
Less mortgage interest	- 8,948,400	- 8,826,450	- 8,688,975	- 8,534,175	- 8,359,725
Less depreciation	- 3,636,400	- 3,636,400	- 3,636,400	- 3,636,400	- 3,636,400
Taxable income or tax shelter	$ 7,415,200	$ 7,537,150	$ 7,674,625	$ 7,829,425	$ 8,003,875
Add tax benefit or deduct taxes (28% tax rate)	2,076,256	2,110,402	2,148,895	2,192,239	2,241,085
Net operating income	$ 20,000,000	$ 20,000,000	$ 20,000,000	$ 20,000,000	$ 20,000,000
Add tax benefit or deduct taxes (28% tax rate)	2,076,256	2,110,402	2,148,895	2,192,239	2,241,085
Less mortgage payment	- 9,909,900	- 9,909,900	- 9,909,900	- 9,909,900	- 9,909,900
After-tax cash flow	$ 8,013,844	$ 7,979,698	$ 7,941,205	$ 7,897,861	$ 7,849,015
Present worth of one, 12%	0.869565	0.756144	0.657516	0.571753	0.497177
Discounted after-tax cash flow	$ 6,968,558	$ 6,033,801	$ 5,221,469	$ 4,515,626	$ 3,902,350

TAB. 3 After tax sales proceeds, year 5

Sales price		$ 200,000,000
Less adjusted cost basis:		
— Cost	$ 150,000,000	
— Less depreciation	- % 18,182,000	- 131,818,000
Taxable gain		$ 68,182,000
Capital gain tax		19,090,960
Sales price		$ 200,000,000
Less taxes	$ - 9 19,090,960	
Less remaining mortgage balance	- 68,808,225	- 87,899,185
After tax sales proceeds		$ 112,100,815
Present worth of sales proceeds $ 112,100,815 × .497177 (pw of 1, 15%, 5 years)		$ 55,733,947
Discounted after tax cash flow		
P.W. of after tax cash flow		$ 26,641,804
Add discounted after tax sales proceeds		55,733,947
Discounted after tax cash		$ 82,375,751

from property characteristics; in fact, experience shows that buyers and sellers of income property tend to be more rational than nonincome property buyers and sellers. The result is that fewer observations are required and that income properties may be appraised without the tedious calculations of the incom appraisal.

These then, are the main options open to real estate appraisers. Now, to come back to my first main point, cash flow models are giving appraisers new options. Notice that in the illustrations given, it was assumed that the net operating income would remain unchanged-which is unlikely in growth and declining areas. Therefore, computer models allow ppraisers to assume a rising or

TAB. 4 Financial Rations (First Year Results)

1. Debt coverage ratio ($ 20,000,000/S 9,909,900) Debt Coverage Ratio = Net Operating Income/Debt Service (DCR = NOI/DS)	201.82 percent
2. Loan to value ratio ($ 75,000,000/S 150,000,000) Loan to Value Ratio = Mortgage Principal/Market Value (LTV = MORTP/MV)	50.00 percent
3. Net present value ($ 82,375,751) - (S 75,000,000) Net Present Value = Discounted After Tax Cash Flow-Equity (NPV = DATCF-E)	$ 7,375,751
4. Profitability indez ($ 82,375,751/S 75,000,000) Profitability Index = Discounted After Tax Cash Flow/Equity (PI = DATCF/E)	1.10
5. Break even point ($ 9,909,900 + S 8,000,000)/(S 28,000,000) × 100 Break Even Point = (Debt Service + Expenses)/ Gross Income (BEP = (DS + EXP)/GI)	64.00 percent
6. Net operating ratio ($ 28,000,000 - S 8,000,000)/(S 28,000,000) Net Operating Ratio = (Gross Income-Expenses)/Gross Income (NOR = (GI-EXP)/GI)	71.40 percent
7. Return on equity ($ 20,000,000/S 75,000,000) × 100 Return on Equity = Net Operating Income/Equity (ROE = NOI/E)	26.67 percent
8. Internal Rate of Return The internal rate of return is that rate that equates the Discounted Cash Flow with Equity	17.55 percent

declining income according to an annual *constant change*,or a *constant rate of change*.In addition, the appraisal is supplemented with financial rations and income and expense data reported on a per unit basis.

By examining a computer appraisal model reporting these features, it is possible to judge appraisal accuracy. Large scale investors, such as pension funds and financial institutions, employ such models to value hundreds of portfolio properties under different assumption of capitalizaion rates, financing plans, and future expectations. In this way appraisers adapt new cash flow models to allow more rational decisions according to the best available analysis. The simplistic direct capitalization and residual appraisal models no longer satisfy investors and others who rely on real estate appraisals.

2. *Statistical Forecasting Techniques*

Forecasts are estimates of future events derived from the recent past and modified according to current conditions. It is implicitly assumed that past events will continue; the combination of computerized data bases and larger computer capacity have led to special purpose forecasting models ideally adapted to income property. Statistical forecasting models help appraisers project income and expenses for monthly, annual, or longer investment periods. These techniques are particularly appropriate for income property appraisals because market value equals the present value of future benefits (net income).

Qualifications

At the outset it is worthwhile to recognize certain forecast qualifications. While computer models may produce precise forecasts, forecasting is still an imperfect art. First, forecasts are usually incorrect. Net income and expenses are partly a function of uncontrollable variables, and consequently, unpredictable. The local economy, government policy, international events, weather and natural catastrophes are such uncontrollable factors impossible to predict. Yet while certain events are unpredictable, management decisions must be based on the best available information. So even though a forecast may not be realized, it provides the best possible estimate of possible outcomes.

Secondly, forecasts are more accurate for grouped data. The forecast of future labor expenses would be less accurate than a forecast of total expenses. By relying on grouped data, the forecaster takes advantage of compensating errors.

Thirdly, it is equally true that forecasts are less accurate for longer periods. The forecast for next month would be more accurate than the forecast for the next 60 months or 120 months. Indeed, the appraiser deliberately selects statistical forecasting models adapted to relatively short or longer terms.

Fourthly, forecasts should be qualified. They are never presented as absolute facts. Forecasts are normally presented with the estimated probability that the forecast will be realized. And lastly, forecasts are never final. Computer records permit continuing review and forecast updates as new data become available. In sum, forecasts give appraisers additional information that contributes to more accurate valuations.

Qualitative Forecasting Models

Qualitative forecasting techniques depend on subjective analysis and personal value judgments. They range from the Delphi method, which is based on a series of questionnaires solicited from experts, to various studies of the probable changes in supply and demand. The Delphi method requires selection of a group of experts who are given questionnaires that are statistically processed to calculate the consensus about some future event. These results are again sent to the panel of experts who are asked to fill out another questionnaire. By successively repeating this process, a consensus is soon reached that represents the majority opinion of informed persons.

Probability models fall in this classification because the forecaster must estimate minimum and maximum values and the probability distribution that future events are likely to follow. Computer models then will calculate the most probable outcome based on these subjective estimates.

Quantitative Techniques

Quantitative forecasting techniques deal with time series analysis or causal models based on multiple regression or econometric models. The more popular time series models include some variation of the models listed below. Various computer programs are available to automatically calculate that forecast which produces the least error term.

Curve fitting	Fitting historical data to mathematical curves to extrapolate future values.
Moving average (single, double, triple)	A weighted average of successive months to eliminate seasonality or data irregularities.
Box-Jenkins forecasting	A systematic method of identifying mathematical models that reduce the average forecast error for seasonal variations, trends, and cyclical changes.

Table 5 lists the gross income, net operating expenses, and net operating income of a 206 unit apartment house over the last six years. Note that annual data have changed from 4.4 percent to 25.1 percent in a single year. Under these circumstances it is unrealistic for an appraiser to assume that net operating income would remain constant or will change according to formula. The alternative is to apply a forecasting model to calculate income for appraisal purposes.

TAB. 5. Annal net operating income statement (206-unit apartment project)

Year	Gross Income	Net Operating Expenses	Net Operating Income
1	$ 1,557,976	$ 516,283	$ 1,041,693
2	1,717,012	629,044	1,087,968
Percent change	10,2%	21,8%	4,4%
3	$ 1,977,113	$ 689,305	$ 1,287,808
Percent change	15.1%	9.6%	18.4%
4	$ 2,228,203	$ 676,757	$ 1,611,446
Percent change	12.7%	- 1.8%	25.1%
5	$ 2,626,888	$ 722,689	$ 1,904,199
Percent change	17.9%	6.8%	18.3%
6	$ 2,989,305	$ 782,850	$ 2,206,455
Percent change	13.8%	8.3%	15.9%

Monthly data for 72 months was subjected to a variation of the exponential smoothing model which decomposed the data into seasonal, trend, and level parameters under the formula:

$$F[t + n] = (L[t] + T[t])\, I[t\text{-}s + m]$$

Where

F	=	forecast
s	=	the length of seasonality (i.e., monthly = 12)
n	=	number of periods ahead to forecast
m	=	seasonal smoothing parameter
I [t]	=	m (y[t] / L÷t]) + (1 - m) I[t-s]
T[t]	=	the trend at time t
L[t]	=	the level at time t
I [t]	=	the seasonal index at time t.

This model produces forecast for t + n periods and requires an estimate for the level of "t", the seasonal smoothing factor, and the trend factor at the time t. To test this model data for the first 60 months were used to produce a forecast for months 61 to 72. The forecast values were then compared to actual gross income as shown in Table 6. The average error, signs ignored, equals 1.4 percent - a highly accurate forecast. The same model was then used to forecast over the next five years for appraisal purposes. Figure 1 shwos the monthly gross income, net operating income for the forecast period and the proceding 72 months.

TAB. 6. Projected gross income compared to actual income for months 61 to 72 (decomposition model)

Month	Actual Gross Income	Projected Gross Income	Residual Error	Percent of Error
August	$ 237,397	$ 236,319	- $ 1,078	- 0.4
September	239,327	243,088	3,761	1.6
October	251,925	246,015	- 5,910	- 2.3
November	244,341	246,173	2,296	0.9
December	245,794	246,173	379	0.2
January	245,532	248,767	3,235	1.3
February	244,738	249,506	4,768	1.9
March	246,631	250,920	4,289	1.7
April	250,683	251,933	1,250	0.5
May	257,803	250,944	- 6,859	- 2.7
June	257,865	256,935	- 930	- 0.4
July	267,268	260,163	- 7,105	- 2.7

3. *Artificial Intelligence*

The preceding computer models are based on *procedural* computer programs. Such programs represent a series of procedures that the computer executes. A procedural program repeatedly executes a program with the same algorithm from given input data. Artificial intelligence programs, in contrast, *solve problems* based on a number of facts and rules to find all possible solutions. The task of the programmer (or appraiser) is to describe the problem so that the computer calculates the optimum solution.

An appraiser applying artificial intelligence uses (1) a computer data base and (2) a collection of facts and rules. Suppose you want to determine if a $ 100,000,000 estimate is the market value of a given property. The appraiser would enter additional facts that are added to the data base. Appraisal facts that are known determine the path that the computer uses to reach the eventual conclusion that $ 100,000,000 is equal or not equal to market value.

For this example market value for property at a given location at a given time, for a given property type would be defined in terms of minimum and maximum values. That is, for an apartment house, for example, data may reveal that for a specific type of property, market value would generally fall within certain dollar limits per floor area.

These data are derived from descriptive statistics of a data base. The limits would represent, say, two standard deviations from the mean or the limits could follow some other statistical measure such as the interquartile range. In other words, the analysis would establish valuation limits in which typical properties would fall. If the appraisal resulted in a value that fell outside these limits, reasons must be given to explain the deviation between the so called normal limits and the appraised value. This application of artificial intelligence rests on the proposition that market value for selected properties must agree with the value of other typical properties and that selected valuation data per unit, show a marked central tendency.

Appraising Warehouses

Attention is next invited to a data base of warehouse properties. The computer file consists of warehouses for lease, warehouses under lease, warehouse for sale, and warehouses sold. Besides ownership information, the data includes the following:

Record number
Street number
Street name
Suite number
Industrial park name
Postal zone
Available square feet of continuous space
Building square feet
Office space square feet
Ceiling height
Railway dock (yes-no)
Sprinkler system (yes-no)
Number of dock high doors
Number of drive in doors
Sales price
Rent per square foot
Asking price per square foot
Is space divisible (yes-no)
Building classification
Ceiling height more or less than 16 feet
Number of parking spaces
Year of construction
Multiple tenant or free standing building
Construction type
Allowance for building office space to suit tenant
Land area

These data are available for several hundred properties in a metropolitan area of about 2.5 million population (Atlanta, Georgia). Data are being processed by various descriptive statistical routines to identify the range of values and the median values in each category. Given these data, it is planned (1) to predict rents and market values by multiple regression analysis and (2) to develop an artificial intelligence routine that selects particular properties on the basis of occupant needs or investor requirements. Given the data base of several thousand cases, it will be readily appreciated that artificial intelligence routines may select preferred properties in the shortest possible time and with considerable accurancy.

Comparable Sales Selection

To explain another application, consider the selection of comparable sales from a sales data base. The appraiser may elect to use artificial intelligence to select comparable sales. Such a program would consist of three parts: a *domain* section, a *predicate* section and a *clause* section. The domain is the value that an argument may take in a particular expression. A clause section represents a database, for instance, a list of real estate sales. This section expresses facts that define relationships among sale prices and property characteristics. A predicate section identifies facts that have values of true or false. Each predicate contains a single fact. For example, given a data base of 50,000 real estate sales, suppose an appraiser wants to select comparable sales for a warehouse appraisal. For a given sale of $ 142,000, the computer would test to see if the property was a comparable sale under the rule:

Comparable sale ($ 142,000)
  Location (2 kilometers or less from a limited access highway)
  Warehouse property
  Concrete construction
  Minimum ceiling height (6 meters).

Thus the rule is that the property sold would be comparable if the four premises are true. The rule would fail if any of the premises required for the rule are false. In plain english, this means that the warehouse sale is comparable, and only comparable, if it is within two kilometers of a limited access highway, if the ceiling is at least six meters high, and if the building sold is constructed of concrete. The computer would then select from the 50,000 item data base those sales that meet the rules established by the appraiser.

Of course, in practice many additional rules would be added. For this problem, the appraiser could enter any number of rules, let us say, 20 criterion before the sale would be accepted as comparable. Suppose further that none of the sales met all comparable sale rules. The computer can then be instructed to change the rules. For instance, sales within four kilometers of a limited access highway would be acceptable or, alternatively, the number of rules could be decreased until sufficient properties were at hand for the appraisal.

To illustrate further consider an actual computer simulation to select a comparable sale from a data base. For this illustration assume the following domains, predicates and clauses. Here the goal is to select an apartment sale of over 100,000 square feet of floor area.

Domain

Property type, construction type, = Symbol
Floor area, location, net income, net yield = Integer

Predicates

Comparable sale (property type, construction type, floor area, location, net income, yield)

Clauses

Comparable (apartment, brick veneer, 800,000 square feet, 3 miles, $ 100,000, 10%)
Comparable (retail building, wood frame, 50,000 square feet, 2 miles, $ 75,000, 8%)
Comparable (apartment, wood frame, 100,000 square feet, 1 mile, $ 20,000, 15%)

Goal

Comparable (apartment, construction type, floor area, location, net income, yield) and > 100,000 suare feet

The computer would them print out:

1 solution
Apartment = brick veneer, 800,000 square feet, 3 miles, $ 100,000, 10%

The goal statement represents an instruction to the computer to find all cases in the data base that meet requirements of the goal.

Appraisal Investment Model

To cite a more complex appraisal-investment model, consider a data base of income properties that has the following data:

Gross potential rents
Vacancy allowance
Other income
Operating expenses
Net leaseable area
Land area
Assessed values
Land and building
Annual real estate taxes
Land value
Original cost
Personal property value
Building value (for tax purpose)
Mortgage principal
Mortgage interest
Mortgage term
Depreciation method
Marginal tax rate
Discount rate
Annual growth in income
Annual growth in expenses
Equity
Expected sale price

For each property, the model produces a projected income and operating expense statement for the next five years. In addition, the program calculates (1) before and after cash flow for five years, (2) relevant financial ratios ; and income and expense data per square foot. See the output listed below:

Before and after tax cash flow	Gross possible income per square foot
Net present value	Net operating income per square foot
Profitability index	Before tax cash flow per square foot
Internal rate of return	After tax cash flow per square foot
Cash-on-cash	Expenses per square foot
Overail percentage yield	Value per square foot, land and building
Break even ratio	
Debt service coverage ratio	Assessed value per square foot, land and building
Loan-to-value ratio	
Payback period	Real estate taxes per square foot

Given this input and output, the next task is to select or identify certain investments that meet minimum investment goals. Suppose the investment goals were identified as

A minimum down payment or equity of S 500,000
Net present value of 1.0 or more
Profitability index of |X.2 or more
Internal rate of return of at least 15%
Minimum cash on cash return of at least 8%

The program allows any combination of investment goals for this calculation. In the case at hand, it was found that two properties met these requirements as indicated below.

Property Name	Down Payment	Net Present Value	Profitability Index	Internal Rate of Return	Cash on Cash
Dutch Manor Apartment	$ 460,000	$ 182,593	1.4366356	0.1953428	0.08014609
One post office square	$ 100,000	$ 84,224	1.9264693	0.2855175	0.12811290

Investment goals may be changed or added as required. With a data base of several hundred investment properties, the virtues of artificial intelligence for valuation and other purpose seems fairly obvious.

These illustrations are suggestive of the broad applications of artificial intelligence to an income property appraisal. Programs are currently available that select forecasting models to produce the least possible forecasting error. Statistical routines are available to select mathematical curves of the best fit.

Other programs have been used to diagnose illneses, given a set of symptoms common to each disease. On college campuses, other innovators have applied artificial intelligence to match dating partners that have similar likes and dislikes. Surely, as our real estate data base increases in size and complexity, appraisers have the opportunity — and even the responsibility — to build valuation models that employ artificial intelligence and that have the highest possible accurancy.

3. *Conclusion*

Advancing technology encourages appraisers to apply refined appraisal models. Before and after tax cash flow models, with selected financial ratios, allow valuators to report alternative "scenarios". These techniques enable investors to base decisions on more accurate and more revealing appraisals.

Statistical forecasting models include routines that calculate all possible solutions to minimize the forecasting errors. Forecasts, based on historical data, seem preferred over personal value judgments over future income expectations. Artificial intelligence, that combines a computer data base with program logic, represents another promising refinement of the appraisal process. The end result produces a valid estimate of market value: nothing more than market value and nothing less than market value.