SAUDER
School of Business

Real Estate Division

LESSON 5

Statistical Analysis and Computer Applications Case Studies

Note: Selected readings can be found under "Online Readings" on your Course Resources website

Assigned Reading

1. UBC Real Estate Division. 2014. *BUSI 344 Course Workbook*. Vancouver, BC: UBC Real Estate Division. Lesson 5: Statistical Analysis and Computer Applications Case Studies

Recommended Reading

1. UBC Real Estate Division. 2010. *Appraisal of Real Estate (Third Canadian Edition)*. Vancouver, BC: UBC Real Estate Division. p.18.9-18.11 and Appendix B.

2. UBC Real Estate Division. 2011. Real Estate Investment Analysis and Advanced Income Appraisal. Vancouver, BC: UBC Real Estate Division. Chapter 9

3. Goddard, B.L. 1999. "The Role of Graphic Analysis in Appraisals". *Appraisal Journal*. 67(4). pp.134-141.

4. Goddard, B.L. 2000. "The Power of Computer Graphics for Comparative Analysis". *Appraisal Journal*. 68(2). pp.429-435.

5. Hartwig, F. and Dearing, B.E. 1979. *Exploratory Data Analysis*. Sage University Paper Series on Quantitative Research Methods. Vol. 16. Newbury Park, CA: Sage.

6. Kincheloe, S.C. 1993. "Linear Regression Analysis of Economic Variables in the Sales Comparison and Income Approaches". *Appraisal Journal*. 61(4). pp.576-586.

7. Jackson, T.O. 2005. "Evaluating Environmental Stigma with Multiple Regression Analysis". *Appraisal Journal*. 73(4). pp.363-369.

8. Winston, W. 1998. *Financial Models Using Simulation and Optimization*. Newfield, NY: Palisade Corporation.

9. Weaver, W. and Michelson, S. 2003. "A Practical Tool to Assist in Analyzing Risk Associated with Income Capitalization Approach Valuation or Investment Analysis". *Appraisal Journal*. 71(4).pp.335-344.

10. Rabianski, J. 2005. "Size Adjustments: A Technique to Estimate Magnitude". *Appraisal Journal*. 73(4). pp.397-407.

Learning Objectives

After completing this lesson, the student should be able to:

1. critically analyze a real estate situation to determine the potential for a statistical or computer-based solution;

2. apply techniques learned throughout the course in finding innovative and creative solutions to client issues;

3. discuss the advantages and disadvantages of different computer and statistical applications in a variety of real estate situations;

4. evaluate statistical results in terms of their accuracy, relevance, and helpfulness in solving client issues; and

5. explain technical results in clear language that a layperson could understand.

Instructor's Comments

After having spent many, many hours on the theory, principles, foundations, and practices of statistical and computer applications in real estate, we now want to advance our discussion with further practical, realistic examples. Students sometimes find that after all this technical information, they can no longer "see the forest for the trees". In other words, the "big picture" of why you are doing this can become obscured by the seemingly endless details. In this lesson, we will attempt to showcase some real world examples of how practitioners are using statistical and computer applications in their everyday work. We hope to emphasize that when you are faced with a difficult real estate problem, you should be thinking of creative and innovative ways to approach and solve them. Data analysis using statistics is one of the most powerful tools you can use to achieve this goal.

For this lesson, we asked several real estate practitioners to provide short case studies on how they have personally used statistical analysis in their appraisal work. We also reviewed some recent appraisal publications that explained innovative statistical applications. The cases illustrate what goes on behind the scenes when practitioners carry out real estate analysis: how statistics were used to support decisions and to narrow down alternatives, deciding what information to focus on, and figuring out what might be unnecessary. We will emphasize how these concepts are useful in everyday work, helping to answer compelling or troubling questions and providing clients with valuable solutions that might otherwise be difficult or impossible.

The examples tend to be focused on valuation, but we have attempted to keep them as applicable as possible to many aspects of real estate, for practitioners such as real estate salespeople, developers, appraisers, property managers, and investors.

You will notice that the level of analysis varies significantly, from basic tools such as graphic analysis to in-depth and complex applications. For example:

- Simple summary statistics can be useful in quantifying change and performing neighbourhood analyses.
- Confidence inferences can be drawn from measures such as the standard deviations of raw and adjusted sale or rental data.
- Regression analysis can be applied to estimate trends and to isolate and test the significance of specific trend determinants.

You should use the tools with which you are comfortable and that are best for the job, remembering that the more tools you learn to use, the better you will be as a real estate professional.

Keep in mind that statistical analysis can be a lethal weapon if used carelessly. Because of the dangers in incorrectly applying statistics, it is often good practice to rely on statistical tools primarily to test or support other more direct procedures. Be careful about purely statistically derived answers to your real estate problem: the use of statistics does not replace expert judgment, but is only one more tool that can be used to help form your expert opinion.

Supplemental Notes on the Recommended Readings

The recommended readings are provided for students who wish to read more about innovative and creative statistical and computer applications in real estate. These are optional and will not be tested in the course.

- Goddard: Computer graphics, which accurately demonstrate market patterns, can be used to enhance data exploration and improve the clarity and usefulness of a report. For the relatively small sets of comparable data used in commercial and complex residential appraisals, graphic analysis can be used to draw inferences about the attitudes and behaviour of the market. Goddard explains practical applications for graphic analysis and identifies possible pitfalls.

- Hartwig and Dearing: The data examples are non-real estate, but serve well as a non-technical primer on graphical data analysis.

- Kincheloe: A linear regression analysis is used to examine economic variables, such as sale price per square foot and net operating income per square foot.

- Jackson: Multiple regression analysis is used to estimate the risk-related effects of environmental stigma on property value.

- Winston: This book examines the use of simulation applications for options pricing, portfolio optimization, acquisitions modeling, and value-at-risk (VAR).

- Weaver and Michelson: This paper presents a simple discounted cash flow model in Excel which measures the standard deviation of a forecasted value.

Statistical Analysis and Computer Application Case Studies

Case Study 1: Statistical Analysis and Residential Valuation

The focus of this case study is on the application of simple statistical analysis to augment traditional appraisal methods for residential properties.

The key points are:

- The Multiple Listing Service® (MLS®) is an important source of statistical data that can be processed into useful information.
- Measures of central tendency can be used as a test or cross-check for market value estimates.
- Statistical analysis can help the appraiser identify a probable value range, a time-adjusted value benchmark, and an indication of possible adjustments.

Statistics, properly applied, can serve as a useful supplement and cross-check for value estimates from traditional appraisal approaches. In this case study, we will examine how one appraiser uses statistics in the Neighbourhood Description and Sales History sections of the standard residential form report.

Neighbourhood Level Statistical Analysis

As a part of the Neighbourhood Analysis section of the report, the analyst searches Multiple Listing Service® (MLS®) sales in the subject property's neighbourhood to find the median market value for a typical property. The analyst compares this to the subject's estimated market value to see if the estimate falls within neighbourhood norms. This statistical test is based on the appraisal principle of conformity which states, "to maintain maximum value, land must be utilized to reasonably conform with the existing standards of the area". The approach is somewhat similar to an assessment Sales Ratio study.

Consider, for example, a valuation for a one-bedroom suite in a high-rise condominium. If there are sufficient sales, the data search may be confined to condominium sales in the subject's neighbourhood over the past three months. However, if the initial search parameters provide an insufficient number of sales for a statistically valid sample (to avoid excessive bias from an individual sale, for example), then the appraiser relaxes some of the initial parameters with the exception of the type of property (e.g., high-rise condominium). For example, the appraiser could increase the time period to six months or widen the geographical area to include other similar neighbourhoods. When sufficient reliable data has been accumulated and verified through data exploration, the appraiser then determines the neighbourhood's median sale value. The median sale value reflects the price of a typical condominium apartment in that neighbourhood. Given the typical distribution of real estate sales information (e.g., data is generally skewed), the median is usually a better indication of central tendency than the mean.

At this point, a price range for the typical property can be measured, either through measures of dispersion (such as the standard deviation or coefficient of dispersion) or by manually reviewing the data. The goal is to identify the price range of at least two-thirds of the condominium sales in the neighbourhood. A quick way to look at this data would be to see how many condominium sales lie within 33% of each side of the median value. For example, if the median sale price is $100,000, then the range to be analyzed is all sales between $67,000 and $133,000. If more than two-thirds of the sales are captured, then 33% on either side of the median is probably too wide a range. Try reducing the percentage adjustments below 33% of the median and see the results. Repetitive trial and review will develop skill and accuracy.[1]

Now that the median and price range of the typical one-bedroom condominium in the neighbourhood have been determined, it is necessary to relate this typical condominium to the subject. Is the subject inferior, similar, or superior to the typical property?

If the property is similar in most aspects such as age, floor area, lot size, and location, then the value estimated by direct comparison should be near the median price. If the subject property is inferior, then the value estimate should lie between the median and the lower limit of the price range. Conversely, if the subject is superior, then the estimate should lie between the median and higher limit.

Of course, it is possible for the final estimate to be outside of the price range. Properties that lie outside of the typical range (outliers) should be given special attention as these properties would be in less demand than the typical and in most cases would require an extended marketing period. In this case study, examples of outliers may include condominiums with very poor or exceptional views, floor level or adverse influences (e.g., above a night-club), or units with extensive customization, possibly over-built for the neighbourhood. All of these are characteristics a client would like to know!

Let's assume the six month neighbourhood median condominium sale price is $213,000 with an average 35 day marketing period. The sale price range for typical condominiums in this neighbourhood is $171,000 to $259,000. The subject is 24 years old and has 555 square feet of floor area. It is smaller and older than the typical 850 square foot, 12 year old condominium. Therefore, the property's market value should lie between the median and lower limit of the price range, that is $171,000 to $213,000.

[1] Another way to carry out this analysis, without requiring trial and error, is to view the distribution using percentiles. This can be done in Excel or SPSS.

In order to capture sufficient sales in the above example, both the geographical area and time period had to be expanded. By doing so, the number of sales was increased to 84. Reviewing the sales showed that the raw data fell within a range of $146,000 to $319,000. However, most sales fell within the narrower range of $171,000 to $259,000 which is roughly a 20% variation around the median price.

At this point, the direct comparison approach has not yet been undertaken, but there is a degree of confidence that the market value of the subject condominium will be in the range of $171,000 to $213,000. The mid-point of this value range is $192,000, which is within about 10% of the lower limit and upper limits of this value range.

An interesting side-note is that if the appraiser compares the subject to the data pool, filtered by similar age, size, and neighbourhood, then price per square foot of living area can be used as additional support for the value estimate. For example, assume the subject property is in the XYZ neighbourhood. If we set a search parameter for condominiums that bracket the subject's age by 10 years (14 to 34), we would find that the median price for a 950 square foot condominium is $203,000. This amounts to a price per square foot of $214, with smaller units of 400 to 600 square feet exhibiting a higher price per square foot of $265. Because the subject is smaller than the typical condominium that is between 14 and 34 years old, its price per square foot will be nearer the $265 rate. If the subject had been similar in size and other aspects to that of the typical condominium in the subject property's age range, then the price per square foot rate of $214 should more closely support the value estimated by direct comparison.

Generally, when analyzing residential condominiums, only the direct comparison approach is relied upon. If one or more of the three to five comparable sales shown in the report has sold for either less or more than its forecasted market value, then the value estimate of the direct comparison approach will be skewed. This may lead to an under- or over-valuation of the property. However, use of a much larger data sample, in our example a database of 84 sales, avoids this potential valuation error, since additional market evidence and statistical analysis allows a deeper understanding of neighbourhood trends.

Sales History Analysis

In the Neighbourhood Analysis section, we focused on comparing the subject's physical composition to a typical property. Here, we will examine the change in general market conditions, showing how property values have changed over time.

The dataset is now selected based on date of sale. A general rule is that data collection should be restricted to properties of the type being analyzed. Once a dataset has been extracted and verified, the analyst takes the following steps:

1. Determine the current median sale price for properties of the subject type in the general area;
2. Identify a prior sale of the subject property;
3. Determine the median sale price for similar properties at the time of the prior transaction;
4. Express the difference between the medians as a percentage change; and
5. Apply the percentage change to the prior sale price of the subject in order to calculate what its current sale price should be, assuming its market value has changed at a similar rate and direction as similar properties in its general area.

This test provides support for the final estimate of value. This analysis can also help determine value loss from events occurring since the prior purchase such as impairment, road widening, "grow-ops", and close proximity to a new rapid transit line. Note that this methodology is somewhat similar to the sales indexing approach used by Teranet reavs, which is described later in the AVM lesson.

Let's examine a condominium example of this technique.

According to the XYZ Real Estate Board, the subject is listed for sale at $185,000 with a reported offer to purchase of $163,750. MLS® records show that the subject previously sold eight years ago for $110,000. A sales history analysis indicates that the median price for condominiums increased from $145,447 to $246,650 over this time, a 69.58% increase from the date of the prior sale. A cross-check on the final estimate of value, using this change in median sales prices, is calculated at $186,500 ($110,000 × 1.6958). This assumes the subject originally sold at fair market value, the physical characteristics of the property have not significantly changed since the date of the prior sale, and the subject has moved evenly with the market. This test indicates the offer of $163,750 is below our rough estimate of the condominium's current market value – further investigation may be worthwhile.

Your further research finds this condominium complex was recently diagnosed with building envelope failure (e.g., water infiltration problems; that is, it was a "leaky condo"). Repairs to the complex are complete and a Special Assessment of $30,000 has been paid by the vendor. However, given the difference between the offer and the time adjusted price estimate, you suspect the prospective purchaser may have further discounted the property due to the impairment and risk of additional costs. You could, in fact, take this discount to be somewhere near $22,750 ($186,500 – $163,750).[2] Our statistical analysis has quickly determined a rough amount for a potential adjustment for this issue, without resorting to time-consuming paired sales analysis. In many cases, adjustments in the direct comparison approach are extremely subjective and difficult to support. This technique may offer one further method of support.

Implications of Case Study

This case has illustrated two simple statistical analyses that go one notch further than the analysis in many residential form report appraisals. Without a huge effort, the appraiser can identify a probable value range, a time-adjusted value benchmark, and an indication of possible adjustments.

Keep in mind that we provided a simplistic example which may not have all the complexities we see in everyday practice. Our intent is not to give a step-by-step guide that works in all situations. Instead, we are presenting some basic techniques to illustrate how statistical analysis can be used to help focus on the "big picture". To return to the metaphor we used at the beginning of the chapter, we hope these examples highlight the importance of keeping an eye on the forest whilst appraising the tree.

Case Study 2: Market Analysis Using MLS® Statistics

The focus of this case study is demonstrating how readily available Multiple Listing Service® (MLS®) statistics can be used to analyze and forecast market demand.

The key points are:

- Published statistics can be analyzed in innovative ways in order to stay ahead of the competition and deliver value-added services for clients.
- Real estate professionals are encouraged to keep their own databases and develop their own analyses as a source of competitive advantage.

This case study is from an appraiser/consultant in Victoria, BC, who analyzes MLS® statistics to obtain a personalized and intensive look at market changes. The study measures this real estate market's tendency towards increasing demand (acceleration), supply and demand in equilibrium (level), or decreasing demand (deceleration). Our illustration focuses on the single family dwelling (SFD) market in the Capital Regional District (CRD, Victoria, BC).

[2] It has not been uncommon in Western Canada for residential condo complexes with building envelope failure to undergo remediation more than once to correct issues.

As an example, the appraiser/consultant explains how this analysis was used in Fall 2006 to accurately forecast the market's impending abrupt levelling off and subsequent drop. This market knowledge was the basis for advising a client, an owner of a retirement residence, considering redeveloping the site to higher density, to instead wait a few months until Spring to see the state of the market.

Market Information

The following market and demographic information provides background for the MLS® data studied in this case:

- CRD population of 330,000 (2001 Census);
- area of 100 square miles;
- inventory of approximately 77,000 SFDs, 24,000 townhouses and attached dwellings (including 700 rental units), 43,000 apartments (including 24,000 rental units), and 2,000 mobile homes;
- sales over the period 1993-2012 varied from 3,100 to 5,500 per year for an average of 4,300 sales of SFD per year; and
- inventory turnover rate is 77,000 SFDs ÷ 4,300 sales per year = 18 years.

Market Analysis

Each Canadian Real Estate Board publishes statistics for listings, sales, and expired listings for all types of properties. This information can be used to analyze various aspects of the real estate market, such as:

- trend in supply;
- trend in demand; and
- acceleration/deceleration of demand.

Acceleration or deceleration of demand for real estate is of great interest for real estate professionals who are involved with financing, planning, developing, and selling real estate because it provides a way to measure market risk. If demand is accelerating, this reduces the probability of risks associated with real estate decisions, such as commencing a new development, expanding an existing one, or hiring additional staff. Conversely, if demand is decelerating, then the probability of risk is increased. If the market is level and there are no signs of either acceleration or deceleration, then market forces are in balance and risk can be said to be "normal".

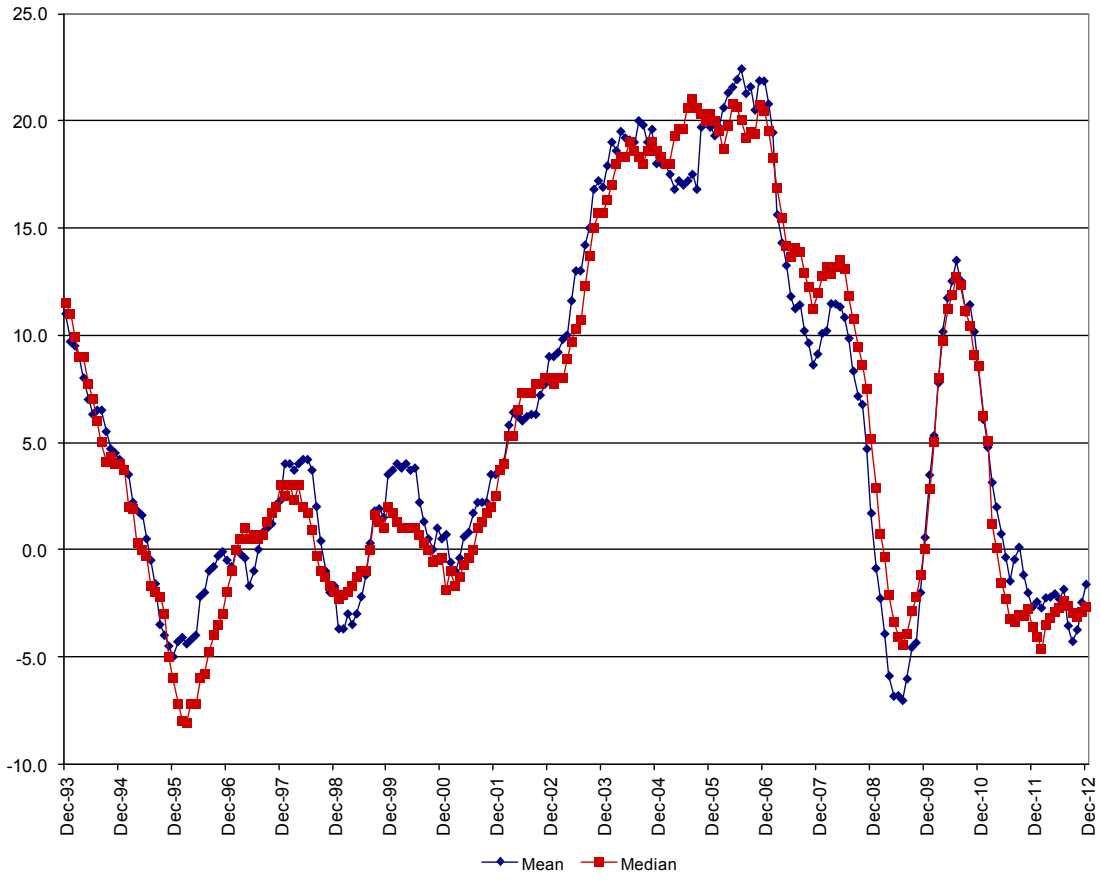
Consider Figure 5.1, which illustrates Victoria's market deceleration in early to mid 2006 (the left axis shows the rate of change of the mean and median selling prices).

This graph is based on a typical group of 350 sales per month using a *moving average*, completed in Excel. The mean (or median) monthly sale prices, over the twelve month period that precedes the current twelve month period is subtracted from the mean (or median) monthly sale prices over the current twelve month period. This difference is divided by the mean (or median) sale prices over the preceding twelve months in order to reflect an annualized percentage change in market activity. For example, the December 2006 data for the mean is determined as follows (with "Avg Mean" referring to the average of the 12 monthly mean sales prices):

$$\frac{\text{(Avg Mean of SFD Price for Jan 2006 to Dec 2006)} - \text{(Avg Mean of SFD Price for Jan 2005 to Dec 2005)}}{\text{(Avg Mean of SFD Price for Jan 2005 to Dec 2005)}}$$

The equation for the median graph is the same as the equation for the average graph, but with the term median substituted for mean.

Figure 5.1: Single Family Dwelling Price Trend – Year to Year



With regard to the "mean" line in Figure 5.1, the December 2006 point (about two-thirds along) shows a 12-month average sale price, over the period January 2006 to December 2006, that is 22.0% higher than the 12-month average sale price over the period January 2005 to December 2005. This 22.0% increase, by itself, does not convey very much information. However, when tracked over time, this calculation can produce valuable market activity information.

What the Results Mean

Over the period July 2001 to September 2004, note that the year-to-year annualized mean price increased from 1.7% change over the previous year (i.e., comparing July 2000 to July 2001) to 19.8% in September 2004 (i.e., comparing September 2003 to September 2004). The median increased at a similar rate. The rate of change increased over the period; in other words, there was acceleration in the rate at which annualized mean (and median) sale prices were increasing. The underlying reason for this was increased market demand, with purchasers raising offer prices in SFD bidding wars.

Over the period October 2004 to January 2006, the rate of change was fairly constant in the 18% to 21% range. Strong market demand was still causing prices to increase, but the strength of that demand was no longer increasing as it had been doing over the period July 2001 to September 2004. Market demand was still increasing 18% to 21% per year, but the rate was no longer accelerating. Market transactions were still strongly in favour of sellers – the real estate SFD fire was still hot, but gasoline was no longer being poured onto it.

Over the period July 2006 to December 2007, the rate of change in the annualized average sale price decreased from 22.4% per year to 9.1% per year. This demonstrates a rapid slowdown in market activity. Again, prices were still increasing, but the rate of change was decelerating.

Analysis of the acceleration and deceleration phases of the market indicate that the rate of change in demand in the market increased at a mean rate of 0.5% per month between July 2001 to September 2004, and decreased at a mean rate of 0.74% per month between July 2006 to December 2007. The rate of decrease was roughly 50% faster than the rate of increase. Deceleration occurred much more rapidly than acceleration occurred.

A developer considering a project at a time when market demand was accelerating would have been justified in being optimistic and taking on greater risk, assuming all approvals and financing were secured (e.g., no delays in project initiation), whereas a developer considering a project at a time when market demand was decelerating would have been wise to reduce risk by cutting back on the project scope or pursuing alternative non-SFD projects (e.g., institutional or commercial construction).

The example in this study shows how one appraiser/consultant used statistical analysis to look at a market in its entirety and judge the state of demand in that market for single family dwellings. Plotting mean and median indicators of central tendency provides one measure as a cross-check on the accuracy of the other. Again, this chart is just a tool. Interpretation of the information provided by that tool is up to the analyst.

This case study highlights the benefits of gathering market data and using the power of the computer for organizing the data and displaying meaningful data relationships. Real estate practitioners can often rely on secondary data providers, such as CMHC or others, but this means their analysis is limited to only what these providers have chosen to pursue. Also, and perhaps more importantly, relying on secondary data providers means relying on the same data as everyone in the market. Being able and willing to gather and analyze your own data can be a source of competitive advantage. After all, if the data is already analyzed and these analyses publicly available, what are clients paying you for? How do you stay a step ahead of your competitors if you all have the same information?

Case Study 3: Size Adjustments using Graphical Analysis

The focus of this case study is the use of graphs to determine non-linear size adjustments.

The key points are:

- Visual or graphical analysis is a useful method for understanding the influence of explanatory variables when comparable data is scarce, often the case for unique properties or those in rural areas.
- Once adjustments have been made for other major variables, a chart trendline can be used to isolate and explain the value effect of a key variable. In this case study, the variable of interest is size, but this approach could apply to other variables as well.
- For most appraisal problems, there is more than one way to approach and solve them. Here, we used a graphical approach to isolate a size adjustment; in Lesson 3 we used a mathematical approach; both are perfectly acceptable.

Because no two properties are identical, comparable sales nearly always require adjustment. Paired sales analysis, regression, and other mathematical approaches can all be used for adjustment support, except in situations where there is insufficient market data. In this case, one alternative may be to use an XY scatter plot for the dependent variable against an independent variable to estimate how the independent variable influences market value. In this case, we will illustrate price per acre against land size.

In Case Study 4, we will show how non-linear data can be transformed to a logarithmic scale in SPSS, creating a linear relationship and isolating the size adjustment. In this case study, we will simply rely on the visual (i.e.,

graphical) data relationship to quantify this adjustment. This method is simple and easy to explain to a non-technical audience, such as a client relying on the information for a real estate decision.

Appraisal Information

This case study focuses on quantifying a size adjustment factor for a rural acreage property valuation. The following information is available:

- Effective valuation date of June 1, 2006.
- Subject property is a vacant, 45 acre, level, cleared, rural lot that does not have subdivision potential in the foreseeable future.
- There are four comparable sales (indices) with similar market attributes to the subject property, except for market conditions and size. In this example, the indices have been adjusted for market conditions, but size has not been adjusted for yet.
- The unit of comparison for this acreage market is sale price per acre.

The following table indicates a market value range of $4,600 to $9,000 per acre (rounded) for the subject property, prior to size adjustment, but after adjusting for market conditions:

				ADJUSTED FOR MARKET CONDITIONS	
INDEX	SALE PRICE	SALE DATE	AREA (Acres)	SALE PRICE	PRICE /ACRE
1	255,000	Nov-05	29.65	266,551	9,000
2	320,000	Apr-05	65.10	349,128	5,400
3	425,000	Feb-06	86.00	435,897	5,100
4	515,000	Feb-06	115.00	528,205	4,600

The subject is 45 acres, so the best indication above is the value range likely lies between $5,400 per acre and $9,000 per acre (i.e., between the adjusted sale prices of the 29.65 acre and 65.10 acre properties). However, this range is too wide to make any definitive conclusions about the subject's market value. At this point, the appraiser has two choices: return to data exploration and seek additional comparable sales within the market area or continue working with the small comparable dataset. Assuming additional research of the market area will not yield better information, the appraiser must rely on the current comparables and find a way to adjust for the size differences in order to narrow the value gap.

Adjustment Process

The initial market investigation found insufficient sales of level, cleared, rural land in the subject market area to permit using paired sales or regression analysis to extract percentage size adjustments. The appraiser investigated size relationships in another market area (Area B), which has similar attributes but is 25 miles distant. The inherent assumption (which should be stated in the appraisal report) was that the effect of land size on market value should be the same in both market areas. Appraisers in rural areas often deal with incomplete or anomalous data and must apply appraisal judgement to solve these issues.

In Area B, the appraiser found 11 sales of level, cleared lots with somewhat similar location and functional attributes relative to the subject property (see table below). While some of these sales were dated, they represented the best available information. The appraiser concluded that the sales must first be adjusted for market conditions, and then could be used to isolate the influence of size on sale price. This relationship, once verified, could then be applied to the subject property and four comparable sales, to account for size differences.

Area B Comparables

ADDRESS	SALE PRICE	SALE DATE	AREA (Acres)	ADJUSTED FOR MARKET CONDITIONS	
				SALE PRICE	PRICE /ACRE
649 Plank River	140,300	Sep-05	14.91	145,044	9,728
Lot 1 Beck	240,000	Oct-05	29.28	245,751	8,393
2191 E Whiley	170,000	Feb-05	29.65	178,131	6,008
Sec 9 White Rapids	125,000,	Dec-04	41.25	136,238	3,303
Lot 2 Olds	125,000	Jun-04	44.50	139,998	3,146
1200 Frew	194,000	May-04	52.94	218,266	4,123
1330 MacDove	155,000	Jun-03	58.05	182,922	3,151
33 Woodbank	235,000	Aug-04	65.10	260,841	4,007
Section 19 Piers	165,000	Aug-03	95.00	193,070	2,032
Parcel B Celan	505,000	May-05	150.26	524,722	3,492
Lot 11 Doolant	800,000	Nov-03	322.00	923,997	2,870

Figure 5.2 (created in Excel) illustrates the relationship between adjusted sales price in dollars per acre and size for each sale, after adjustment for market conditions.

Figure 5.2: Price per Acre versus Lot Size

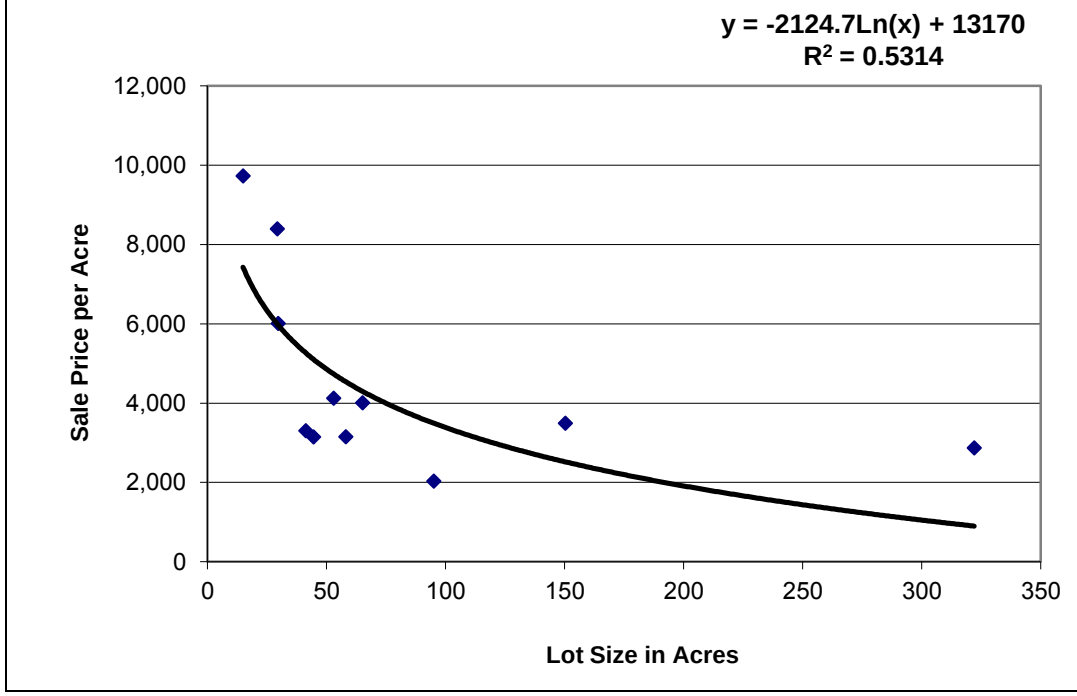


Figure 5.2 shows that as land size increases, sale price per acre tends to decrease in a non-linear fashion. Excel's chart tool was used to add a logarithmic trendline showing the smoothed line of best fit through the sale points.[3] The R-square value of 0.5314 indicates that approximately 53% of the difference in sale price per acre is explained by lot size. Although there are other major attributes that influence sale price per acre, this graph identifies the effect of size on value.

Through visual analysis of the trendline and interpolation, it is possible to identify the following approximate price points for the comparable sales and for the subject property:

29.65 acres: $5,800 per acre;
45.00 acres: $5,000 per acre; (subject property)
65.10 acres: $4,100 per acre;
86.00 acres: $3,700 per acre; and
115.00 acres: $3,000 per acre.

A base adjustment process can then be used to determine the appropriate percentage size adjustments, as follows. For each comparable:

Adjustment = (Subject value per acre – Comparable value per acre) ÷ Comparable value per acre
29.65 acres: ($5,000 - $5,800) ÷ $5,800 = -14%
65.10 acres: ($5,000 - $4,100) ÷ $4,100 = +22%
86.00 acres: ($5,000 - $3,700) ÷ $3,700 = +35%
115.00 acres: ($5,000 - $3,000) ÷ $3,000 = +67%

When these size adjustments are applied to the sales indices, the following results are obtained (adjusted price per acre is rounded to the nearest hundred):

INDEX	SALE PRICE	SALE DATE	AREA (Acres)	ADJUSTED FOR MARKET CONDITIONS			ADJUSTED PRICE /ACRE
				SALE PRICE	PRICE /ACRE	SIZE ADJUSTED	
1	255,000	Nov-05	29.65	266,551	9,000	-14%	7,700
2	320,000	Apr-05	65.10	349,128	5,400	22%	6,600
3	425,000	Feb-06	86.00	435,897	5,100	35%	6,900
4	515,000	Feb-06	115.00	528,205	4,600	67%	7,700

This adjustment process has reduced the market value range to $6,600-$7,700 per acre, considerably more useful than the non-size adjusted range of $4,600 to $9,000 per acre.

For your interest, we also carried out a logarithmic size adjustment method using the technique that will be illustrated in Case 4. After transforming the variables into log functions, the regression result showed a slope of -0.41. In other words, for every 10% increase in size per acre, price per acre decreased about 4.1%. After applying this factor, the indicated value range was $6,200 to $7,600, with a mean of $6,800 (compared to $7,200 for the graphical method, with COVs similar for both). It appears the graphical method provided a reasonable approximation of the values when compared to the more mathematically precise logarithmic method, but with less complexity and more easily explained and understood results.

[3] Adding a trendline to an XY scatterplot in Excel: Select the data to be charted; Insert, and from the Chart sub-menu, Scatter, and click on Scatter with only Markers as the scatter plot type; then when the chart is displayed, click Layout, and under the Analysis sub-menu, click Trendline → More Trendline Options... → select Logarithmic and click select both Display Equation on chart and Display R-squared value on chart → Close

Summary

This example highlights how computer analysis tools can help appraisers explore data visually. Excel was used to graph the sales and create a non-linear trendline, from which "trended" price per acre data points could be identified for the subject and comparable sales. This information was used in a conventional base adjusting process to determine size adjustments for each sales index. Based on this approach, the market value gap was narrowed to $1,100 per acre from the previous, non-size adjusted gap of $4,400 per acre.

Case Study 4: Size Adjustment Using Logarithmic Transformations

The focus of this case study is the use of logarithmic transformations to determine non-linear size adjustments.

The key points are:

- Visual or graphical analysis is critical for better understanding the nature of relationships between variables.
- A logarithmic transformation can be used to linearize a non-linear relationship.
- The slope of this transformed regression line can be used to calculate a size adjustment.

This case study uses the "ontariorural" dataset, a sample of 55 rural residential building lot sales in the Ontario municipalities of Meaford (MF) and Georgian Bluffs (GB). The data includes the sale price, size in acres, and sale price per square foot.

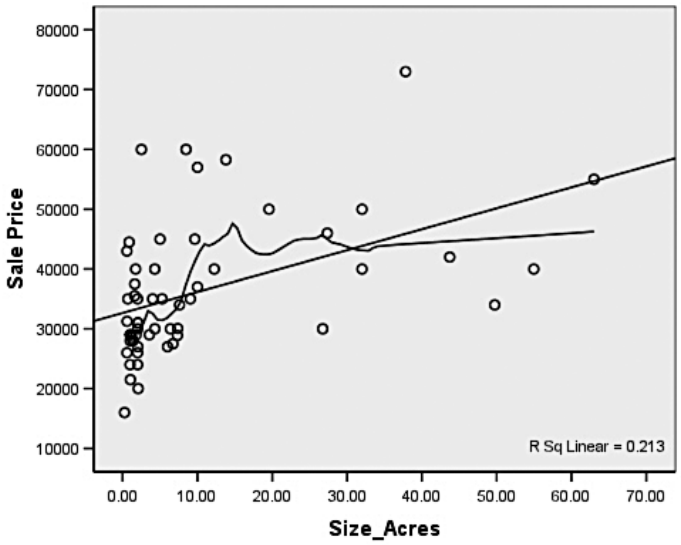
Size-Price per Unit Analysis

Despite sharing the same highest and best use as rural residential building lots, the property sales display a very wide range in size measured in acres, from 0.25 acres to 63 acres. When analyzed, the data on a price per square foot basis show a similar variation range between $0.02 and $1.74 per square foot. Below are summary statistics:

		SalePrice	Size_Acres	SP_SF
N	Valid	55	55	55
	Missing	0	0	0
Mean		36245.42	10.2635	.3524
Median		34000.00	4.0000	.2100
Std. Deviation		11381.517	15.00548	.39290
Minimum		16000	.25	.02
Maximum		73000	63.00	1.74

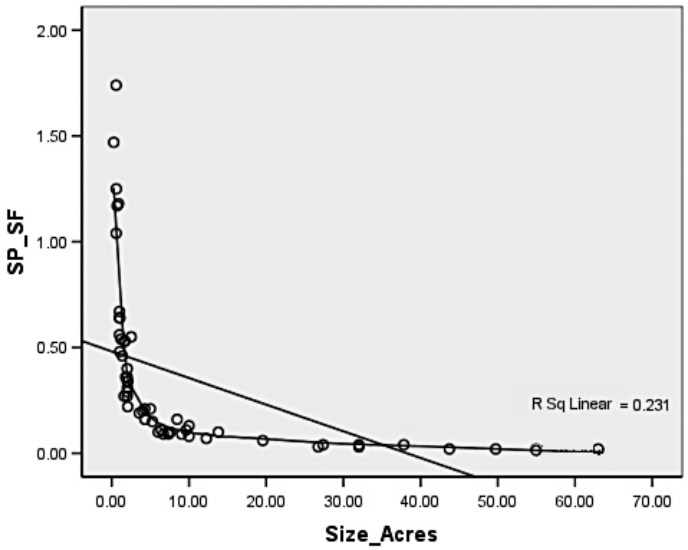
The summary statistics show a mean sale price per square foot of $0.35. In a typical comparative analysis, this would often be the size adjustment. The coefficient of variation (COV) measures the prediction errors when the average is used as an estimator of value (calculated as the standard deviation divided by the mean). In this case, the COV is 111%. This is quite a large error indication, a combination of unadjusted differences between these sales and the subject and random unexplainable error.

We will continue our exploratory data analysis to see if we can better approximate the relationship of price and parcel size and reduce some of this variation. We produce a scatterplot of sale price by size per acre, and fit both the linear and Loess lines.



The R-square for the linear relationship is low, showing a weak relationship between price and size. This is counter-intuitive, as we know that the size of a lot is typically a very important contributor to value. The Loess line shows a significant curve, indicating the relationship may not be linear.

We next examine a scatterplot of the price per square foot of each sale (vertical axis) against their respective size (horizontal axis) and find a dramatic result.



This scatterplot shows a clear non-linear pattern. It appears sale price per square foot and size are inversely related. Price per sq. ft. decreases quickly as lot size increases for properties up to about an acre. Then the decrease in prices continues up to about 10 acres, but the rate of change slows considerably. Finally, although properties between 10 acres and 45 acres continue to show a declining price pattern as size increases, the rate of decline is small. After 45 acres, the market appears to price each additional acre the same.

The graphic analysis has revealed a distinct – but clearly non-linear – pattern. This complicates the extraction of a suitable adjustment factor, an easy task for linear relationships. One available solution is to transform the original data values to a scale where the relationship between the transformed values is linear. For this data, such

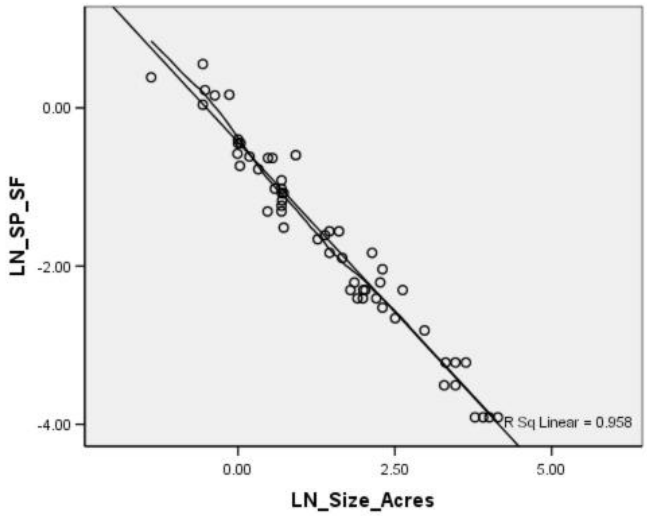
a relationship is found by taking the natural logs of both sale price per sq. ft. and size in acres. In SPSS, you may create these variables by using the Transform function LN(variable).[4]

For the sale price per square foot transformation in SPSS use:

- Transform → Compute Variable...
- Enter LN_SP_SF in the Target Variable box and LN(SP_SF) in the Numeric Expression box
- Click OK.

In Excel you would use the formula =LN(*cell*) to calculate the natural log of the value in *cell*.

The scatterplot below shows the relationship between these transformed values, which is now clearly linear.



We will run a regression of LN_SP_SF against LN_Size_Acres to determine the equation for this line.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.979(a)	.958	.957	.24944

a Predictors: (Constant), LN_Size_Acres

Coefficients(a)

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant) LN_Size_Acres	-.435 -.858	.049 .025	 -.979	-8.927 -34.701	.000 .000

a Dependent Variable: LN_SP_SF

The regression results found -0.435 is the constant and -0.858 is the coefficient for the independent variable, LN_Size_Acres. In other words, the equation is: LN_SP_SF = -0.435 – (0.858 × LN_Size_Acres).

[4] As mentioned in Lesson 3, if you have trouble understanding natural logarithms intuitively, the following article is easy to understand and even fun! "Demystifying the Natural Logarithm (ln)" available *at http://betterexplained.com/articles/demystifying-the-natural-logarithm-ln/*.

The slope of the line is -0.858. This shows the expected percentage change in price for every 1% increase in size; in other words, sale price per sq. ft. declines on average by 8.6% for every 10% increase in site size. The decline in price is not proportional to the increase in size; hence it is nonlinear. The appropriate adjustment factor for size is derived by taking the ratio of the subject property size to the comparable sale size raised to an exponent of -0.858.

For example, let's assume our subject is a 2.5 acre lot and we have a comparable 5 acre lot. This comparable is double the size of the subject and sold for $0.21 per sq. ft. We need to determine a size adjustment. Applying the adjustment factor formula we get:

Size adjustment factor = $(2.5/5)^{-0.858} = 1.8125$
Size adjusted value per square foot = $\$0.21 \times 1.8125 = \$0.38$ per square foot

Thus, if the comparable sale sold for $0.21 per sq. ft., our size adjusted value indicates that if this property had instead been 2.5 acres it would have sold for $0.38 per sq. ft. (assuming, of course, that other factors influencing value have been adjusted for).

Market Value Prediction of Subject Property as if Vacant Lot

This size adjustment factor can be calculated for all the sales in the sample, with the assumption of a 2.5 acre subject property. The transformation equation in SPSS for the size adjustment factor and adjusted sale price per square would be as follows:

Adj_Factor = ((2.5 / Size_Acres)**(-0.858))
Adj_SP_SF = Adj_Factor * SP_SF

where / is divide, * is multiply, and ** is "exponent". For example, Sale 1 is calculated as follows:

Adj_Factor = (2.5 acres / 0.25 acres) ** (-0.858) = 0.139
Adj_SP_SF = 0.139 * 1.47 = $0.20 per square foot

In SPSS, for the first transformation above use:

- Transform → Compute Variable...
- Enter Adj_Factor in the Target Variable box and ((2.5 / Size_Acres)**(-0.858)) in the Numeric Expression box
- Click OK.

In Excel the formula would be = ((2.5 / *cell*)^(-0.858)) where *cell* refers to the cell that contains the size in acres (note: the exponentiation symbol in Excel is a caret ^ – this is a Shift-6 on a most keyboards).

The summary statistics for SP_SF and Adjusted SP_SF are shown below (use Analyze → Descriptive Statistics → Frequencies):

		SP_SF	Adj_SP_SF
N	Valid	55	55
	Missing	0	0
Mean		.3524	.3042
Median		.2100	.2840
Std. Deviation		.39290	.07993
Minimum		.02	.18
Maximum		1.74	.55

The mean sale price per square foot, when adjusted for subject size, now drops from $0.35 to $0.30. The standard deviation shows the size adjustment has lowered the price variation significantly. The coefficient of variation (COV) is now 0.08 / 0.304 = 26%. While this is still a fairly high number, it is a huge improvement from the unadjusted 111%. In other words, the size adjustment has quickly explained a large amount of variation in prices between these sales and the subject. There is still a lot of unexplained variation left, which can be attributed to all the other determinants of vacant land value, for which we have not yet adjusted. For example, market knowledge of the Georgian Bay properties indicates that a view adjustment will likely reduce variation significantly.

The mean of the size adjusted sale price for the 55 properties is $0.30 per square foot or $13,068 per acre. Employing the mean as an estimator, a 2.5 acre rural unserviced lot in the Owen Sound area can be inferred to have a market value of $32,670. Without this nonlinear size adjustment, the $0.35 sale price per square foot would have resulted in a value of $38,115, which appears to be 17% over-valued. Without graphic analysis, the nonlinear nature of the relationship between price and site size might not have been clear.

This case study has graphically illustrated the common tendency for decreasing returns to scale when comparing real estate prices with land or building size. We highlighted how logarithmic transformations can be used to re-express the data to account for this issue.

Case Study 5: Graphical Analysis of Rent and Operating Costs

The focus of this case study is to demonstrate how graphs can be used to illustrate spatial relationships for a commercial real estate analysis.

The key points are:

- A curve illustrating commercial rents by location can serve as a visual cross-check for rental analysis.
- The curve can also help support adjustments for location and market conditions.

The primary driver of market value for income-producing property is its net operating income, or rent less expenses. Therefore, when valuing an income-producing property, a reliable forecast of market rent is paramount.

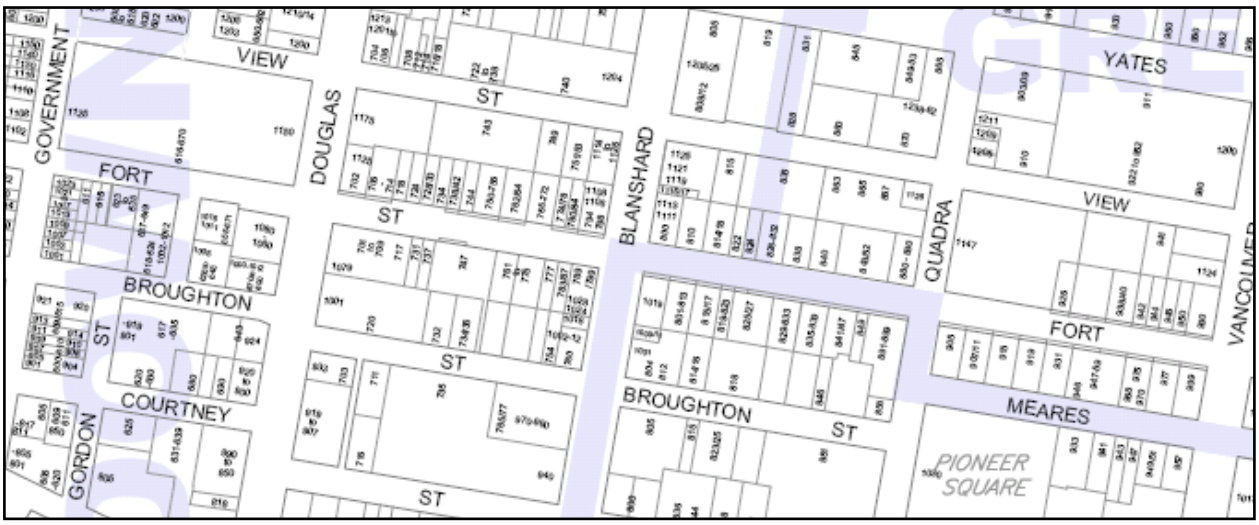
To estimate the appropriate market rent, the appraiser must first survey similar tenancies in comparison to the subject space. Then, the market rent for the subject space is generally determined through various forms of judgmental or non-quantitative forecasting. However, as illustrated in this case study, statistical measures can be used to verify or *cross-check* the reliability of judgmental forecast. We will illustrate a rent analysis for a retail property in the downtown core of Victoria, BC.

Appraisal Information

Our goal is to estimate the current market rent for a single-tenant 3,000 square foot retail building at 750 Fort Street in downtown Victoria. We know the following:

- Fort Street is one of the principal streets in the downtown district, extending east from the 600 block (core of the historic waterfront district) to the 900 block, known as "Antique Alley".
- Subject is average quality shell space with depth/frontage ratio of 2.5 to 1.
- Current market rent based on a judgmental review of comparables is $23 per square foot, absolute (fully net to landlord), over a three-year term with no rent escalation over the term.
- Stabilized operating costs are $8.25 per square foot.
- Overall capitalization rate for this type of retail property is 7.75%.

Below is an address map of the downtown district from the City of Victoria Planning and Development Office.



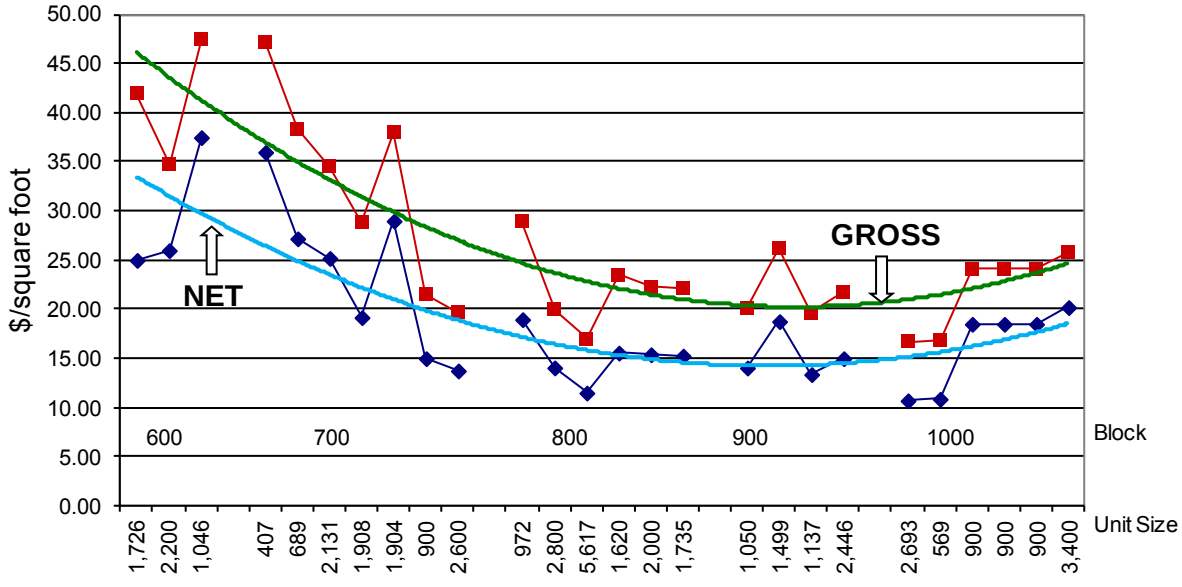
Rent Analysis

Graphical analysis can be used to provide a cross-check of the reasonableness of the rent and operating cost forecasts. To demonstrate this, we will use Excel to create a chart based on ground level retail rents for five key blocks of Fort Street in downtown Victoria. The chart shows retail properties in the 600 to 1000 blocks of Fort Street, grouped together by block. The chart illustrates two relationships:

- gross rent per square foot and block location (upper curve, lighter shaded dots); and
- net rent per square foot and block location (lower curve, darker shaded dots).

A third relationship is also illustrated, showing how price per square foot varies with size of unit. The vertical axis is rent in units of dollars per square foot ($/sf).

Figure 5.3: Retail Rents



We used the Excel trendline function to determine the curves of best fit for the Fort Street rent data. The horizontal axis presents the size in square feet of each retail tenancy. The vertical axis presents the rent value ($/sf). A third variable, block location, 600 to 1000, is also shown along the x-axis. Since address information has been captured for each rent, it is possible to analyze the value relationships by civic block. This location factor is critical because achievable rents are sharply higher for retail properties in the prime downtown shopping district.

The chart visually illustrates that both net and gross rents are highest in the 600 block and decrease to the east along Fort Street. The heart of downtown lies at the intersection of the 600 block of Fort Street and Government Street, so it is to be expected that the highest rents would be at that location.

The subject property lies in the 700 block of Fort Street. Reading from the lower trend line, we can see on the chart that the 700 block of Fort Street has net rents between $19 and $27 per square foot, with the higher rents occurring at the west end of the block and the lower rents at the east end. Our estimate of $23 per square foot for the subject, a mid-block property, lies in the middle of this range. If the rent forecast had been, say, $28 per square foot, this is close enough to the 700 block retail rental range to also be acceptable. It is important to recognize that the purpose of this analysis is not to provide a forecast of the net rent applicable to the subject, but to determine if the forecast appears reasonable. In the event the rent forecast was $30 per square foot, or 15% outside the rental range shown on the chart for the 700 block, it would be necessary for the appraiser to review all data exploration and analysis steps. For example, there may have been errors in the determination of the net rent or rentable area for each of comparable properties.

Keep in mind that this method is somewhat crude since no attempt has been made in the graphical analysis to eliminate the influence of variables such as market conditions (e.g., changes in market over time) and size of rentable area.

The reasonableness of operating costs can be reviewed with the same approach since the vertical gap between the gross and net rent curves represents operating costs. The typical gross rental range in the 700 block of Fort Street varies from $26 to $38 per square foot (reading from the upper trend line), and the typical net rental range varies from $19 to $27 per square foot. Therefore, the typical operating cost range in the 700 block of Fort Street is $7 to $11 per square foot (i.e., subtract net rental range from gross rental range. This is, in essence, the spread between the two trend lines; it is approximately $11 at the left hand side of the 700 block and approximately $7 at the right hand side of the 700 block. The $8.25 per square foot operating cost estimate for the subject property falls within this range.

Based on the foregoing cross-check, the net rental estimate of $23 per square foot and operating cost estimate of $8.25 per square foot both appear reasonable.

Case Study Implications

Maintenance of a rental database is not difficult, but it requires persistence and discipline to continually add to it as rental information is acquired. The proper use of database-generated charts such as the one shown here can provide a good cross-check for the reasonableness of net rent and operating cost projections.

This rental database is also useful for estimating market condition adjustments by block because curves can be drawn from rental information for different years and compared with one another.

It can also help support location adjustments because average mean (or median) net rents on one block can be compared with average mean (or median) net rents on another block to provide a percentage location adjustment. This can be applied to comparable sales that differ primarily by location.

Case Study 6: Quality Point Adjustment Method

The focus of this case study is to demonstrate an alternative method for adjusting comparables in the direct comparison approach, using spreadsheet software.

The key points are:

- A qualitative approach may better reflect how real estate purchasers account for different attributes in comparables.
- The use of computer software can allow integration of automation into the appraisal process, in order to more effectively meet client needs.
- Statistical approaches may permit deeper analysis of data than the human eye/brain can manage, highlighting value relationships that might not otherwise be apparent.

Property appraisal requires considerable subjective judgmental forecasting, commonly referred to as the artistic side of valuation. This case illustrates a price-rating technique called Quality Point (QP) which can be used to reduce this subjectivity. By employing computing power, spreadsheet software, and statistical measures of variation, QP allows appraisers to tap into the wealth of pricing information inherent in sales data.

In our case study example, a client required appraisals for 50 parcels of land. Our preliminary investigation found that a traditional appraisal for each, with well-supported adjustments for each unique subject property, would have been excessively costly for the client. Instead, we used Quality Point's computer analysis to create a standardized scale that required adjustment only once, which significantly reduced the number of direct person hours required while still producing high quality value estimates.

Quality Point is a variant of price-rating sales comparison techniques. In the traditional direct comparison approach, the appraiser estimates the economic contribution (in dollars or percentage) of each attribute for comparable sales. However, this likely does not match how real estate buyers shop for real estate and decide on prices. Buyers attach personal values to combinations of specific attributes. Buyers implicitly follow a qualitative ranking/rating process of evaluation and elimination, match attributes from one property to another, and eventually decide which property provides the greatest amount of satisfaction relative to its cost.[5] QP is based on a qualitative approach that mimics the way buyers rate and compare properties in determining a price.

This case will illustrate a real-world example of how appraisers pursued a creative and innovative solution to a vexing valuation problem and, in doing so, provided valuable advice to the client and established a potential competitive advantage for future. We will provide a quick overview of QP, what it is and how it works. However, we will leave further depth and detail for interested readers to review on their own. The course website provides additional sources of readings and further examples.

Appraisal Problem – Background

A First Nations (FN) client needed rental information for leased seasonal recreational cottage sites on reserve lands. Historically, rents for the leases were established as a percentage of estimated market value for lots grouped into one of twelve value categories. To establish these market values, the client required appraisals of the unencumbered fee simple of a sample of the lots.

The recreational lots, which number hundreds of parcels, are not homogeneous in terms of physical characteristics. They are either on the shore of a large lake, on the bank of a river, or are proximate to these water bodies. The parcels vary in distance to the waterfront, sizes, shoreline attributes, tree cover, and road access. Some tenants have improved the lots with cottages and other site improvements, but the rent is based on

[5] Donald Wilson's paper "The Principle of Rank Substitution", available on the QP webpage (through "Online Readings"), has an excellent discussion of this perspective.

the lot value as if vacant and developable to its highest and best use (seasonal recreational use, improved with seasonal homes).

For this assignment, fifty lots throughout the reserve were chosen to be appraised:

- these ranged in size from 4,026 square feet to 24,500 square feet;
- their frontages varied from approximately 42 feet to 300 feet;
- twenty-one lots had lake frontage and two lots were on the bank of a river that emptied into the lake within the reserve boundaries;
- the remaining parcels were located across the road from waterfront lots (referred to as second tier) or farther from the shore; and
- the lots were serviced with typical rural hard and soft municipal services and utilities, with the FN as the service provider.

Direct comparison was chosen as the most suitable method to estimate the market value of these properties. However, because the fee simple interest of FN reserve property is not available for sale (i.e., Federal Crown land held in trust for the FN), it was necessary to explore the market for sales of similar non-reserve seasonal recreational property.

The comparable sales search discovered two distinct groups of properties, distinguished by price and frequency. The first group, waterfront lots, had scarce sales, which were widely distributed and with inconsistent physical attributes and premium prices. The second group of non-waterfront or interior recreational lots displayed lower prices and were sold more frequently than waterfront lots.

Given the diversity of property attributes, it was decided that each of the fifty properties required a separate valuation. However, this decision impacted the budget and report delivery deadlines, so the valuation team explored appraisal methods that might shorten the time needed yet still produce credible valuation outcomes.

Quality Point Technique

The situation at hand offered very limited transaction data, making it difficult to support quantitative adjustments. QP is designed to exploit limited information, extracting maximum information from a discernable market[6] through an automated weighting technique.

QP as applied here integrates a quantitative and qualitative approach.[7] Each sale was compared to a standardized scale using a set of established rating rules. Once the model was built, it was applied to each subject property without changing the model. Only the subject properties needed to be rated individually. This approach permitted us to inject some automation into the assignment and, incidentally, also provided some consistency in the rating of the sales.

[6] For an in-depth discussion of this concept, see the article by Rodgers, Thomas. 1994. "Property to Property Comparison and Simple Comparison Control". *Appraisal Journal*. January, 1994. p.64-67. This can be found on the QP webpage (accessed via "Online Readings").

[7] Some non-linear relationships between a characteristic and price, like size, are often better modeled with quantitative techniques. Also, the use of linear programming to solve for optimum weights requires at least an equal number of sales and attributes.

Assignment Snapshot – A Single Lakefront Property

We will use the valuation of one of the 50 subject properties to illustrate the application of QP in this assignment. Eight sales were drawn for comparison with the subject property, a lakefront lot. First, the sale price of each comparable was reduced to market units of comparison, in this case, price per square foot. Then, their sale prices were adjusted for quantifiable factors such as market conditions, non-typical financing, motivation, and lot size. See the example in Figure 5.4. The top shaded box is comparable information; the second shaded box shows quantitative adjustments. For example, LF3 has been adjusted +15% for motivation. These preliminary quantitative adjustments brought the comparables to a baseline that reflected the same conditions under which the subject property was to be appraised.

Next, we identified the qualitative attributes of these properties that we believed best explained the remaining variation in their sale prices including shoreline, services, view, and privacy. To this point, the process is the same as practised in the traditional direct comparison approach. It is with the next task that we depart somewhat from the traditional to the Quality Point process.

We then established a set of rating rules for each attribute and rated the comparable properties according to these rules. See the "Scoring Scale" in Table 5.1 for an example.

Table 5.1: Scoring Scale for Waterfront Lots

Shoreline:	7 = fine sandy beach and dunes; very good swimming 5 = sandy beach with some stone and cobble; good to fair swimming 3 = rock or cobble beach; difficult to walk on 1 = steep bluff shore with no beach
Services:	7 = paved road and piped water; year round services 5 = year round road maintenance on hard surface road; all utilities 3 = full year maintenance on loose surface narrow road 1 = seasonal road access and poor condition
View Aesthetics:	7 = good view of shore; exposure includes sunsets 5 = no view obstacles; shoreline visible; western exposure 3 = good view but no western exposure 1 = no view of shore from major portion of lot; no view of sunsets and manmade structures in view aspect
Apparent Naturalness/ Privacy	7 = heavily treed with uneven terrain; excellent separation from neighbours 5 = good tree cover with terrain variation; good separation from neighbours 3 = moderate tree cover; generally open with some screening from neighbours 1 = minimal or no tree cover; flat terrain; close neighbours
Location:	7 = within one hour's drive of major urban centre (population 100,000 plus) 5 = in southern Townships of _____ County 3 = in _____Township 1 = in Townships north of _____

The ratings were input into a matrix grid built in Excel and each attribute was assigned a weight. For example, in Figure 5.4, see the second shaded box from the bottom. The attribute Shoreline accounts for 5% of value, while location 34%, and so on, with the total weights equalling 100%.

The rating for each comparable attribute was then multiplied by the weight. For example, LF1 has ratings of shoreline = 3, services = 3, which were multiplied by weights of 5% and 23% respectively.

Adding up these attribute values for each comparable provided an indication of that sale's "composite quality index" (CQI) or "total weighted *quality point* score".

As a starting point for determining the optimal weighting of attributes, we started with weights decided by the appraiser – in this case, equal for each attribute (this decision is analogous to the judgment applied by an appraiser in reconciling adjusted sale prices in a typical sales comparison grid). This is a subjective decision, entirely dependent on each individual appraiser's opinion, and not defensible beyond "in my expert opinion". To add some objectivity, we now use Excel's Solver utility to solve for the optimum attribute weights. In other words, we are going to use the market evidence to indicate what each attribute's real contribution is to the overall utility of the property (the technical aspects of this will be discussed later in this case study).

Finally, we took each sale's quantitatively adjusted price per square foot (SADJSP – final row in the middle shaded box in Figure 5.4) and divided it by its total weighted quality score ("Composite Quality Index") to obtain a price per quality point per square foot ("Quality Adjusted Price / Point / SF" or QADJSPP). This assumes there exists a directly proportional relationship between the sale's quality point index and the price it fetched on the market.

The desired result is consistent quality scores with limited variation about their centre (measured by the mean or median). Figure 5.5 shows a mean QADJSPP of $1.82 with a Relative Standard Error of 3.59% (RSE is equal to the Standard Error divided by the Mean). This is good result, with low variability. This means we can carry the QP model through to its end use to estimate the market value of the subject property.

To estimate the value of the subject, we first rate the subject in a similar manner to the comparables, then determine its utility index/quality score based on the Solver weights, and then multiply the score by the adjusted sale price per quality point per foot. We will illustrate an example of this next.

Figure 5.4 shows the final QP matrix grid used to value property 1 (LF1). Figure 5.5 shows the subject's valuation using the QP approach.[8]

- The subject's ratings, with the weights applied, result in a 4.97 "Composite Quality Index". This places it in the middle of the quality range indicated by the comparables.

- Dividing this 4.97 QP score by the QP score for each comparable, indicates their quality adjustment relative to the subject. For example, the second to last line of Figure 5.4 shows the subject is 62% better quality than LF1, meaning its $1.54 quality adjusted price per point per square foot is adjusted upward to $7.65 ($1.54 × 4.97 = $7.65).

- Multiplying the 4.97 quality score by the mean $1.82 QADJSPP leads to a price per square foot of $9.04 for the subject. [This could also be found as the average of the TADJSP shown in the bottom line of Figure 5.4.]

- Multiplying $9.04 by the subject's 13,200 square feet results in a market value estimate of $119,000.

- Note the size adjustment factor of -1.3 for the subject. This was already accounted for earlier in the analysis, and is simply being reported in this table. The size adjustment process is discussed further in the following sections.

[8] Figures 5.4 and 5.5 are excerpts from a Quality Point calculation in Excel. You may view the spreadsheet file on the course website, under "Online Readings". Instructions for how to work with this file are provided at the end of this case study.

Figure 5.4: Quality Point Rating Analysis Grid

Property/Sale Details										
Sale Index		**LF1**	**LF9**	**LF3**	**LF6**	**LF7**	**LF10**	**LF18**	**LF19**	**SUBJECT**
Date of Sale		Mar-94	Sep-94	Jun-94	Jun-94	Aug-94	Jun-94	Sep-94	Jun-93	May-96
Water Frontage (feet)		333	150	100	100	202	99	60	68	66
Site Area (SF)		39,326	65,968	15,000	18,015	75,795	49,265	11,500	13,391	13,200
Sale Price		$45,000	$48,000	$97,500	$97,500	$47,000	$71,500	$135,000	$145,000	?
Sale Price/SF (SPSF)		**$1.14**	**$0.73**	**$6.50**	**$5.41**	**$0.62**	**$1.45**	**$11.74**	**$10.83**	**?**
Quantitative Adjustments										
Property Rights Conveyed		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-------
Financing Terms		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-------
Motivation		1.00	1.00	1.15	1.15	1.00	1.00	1.00	1.00	-------
Market Conditions		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	-------
Baseline Adjusted Price/SF Site(BADJSP)		**$1.14**	**$0.73**	**$7.48**	**$6.22**	**$0.62**	**$1.45**	**$11.74**	**$10.83**	-------
Site Size		4.13	8.10	1.18	1.50	9.70	5.54	0.84	1.02	-------
Size Adjusted Price/SF Site(SADJSP)		**$4.73**	**$5.89**	**$8.82**	**$9.34**	**$6.01**	**$8.04**	**$9.86**	**$11.04**	-------
Quality Point Ratings	**WEIGHTS**									
Shoreline	0.05	3	3	7	7	3	3	7	7	5
Services	0.23	3	3	1	1	3	7	7	7	5
View Aesthetics	0.33	5	5	5	5	5	5	7	7	7
Apparent Naturalness/Privacy	0.05	5	5	3	3	5	5	7	7	5
Location	0.34	1	1	7	7	1	1	5	5	3
	1.00									
Composite Quality Index (CQI)		3.07	3.07	4.77	4.77	3.07	3.99	6.32	6.32	4.97
Quality Adjusted Price/Point/SF(QADJSPP)		**$1.54**	**$1.92**	**$1.85**	**$1.96**	**$1.96**	**$2.02**	**$1.56**	**$1.75**	-------
Quality Adjustment Factor		1.62	1.62	1.04	1.04	1.62	1.25	0.79	0.79	-------
Total Adjusted Price/SF(TADJSP)		**$7.65**	**$9.54**	**$9.19**	**$9.73**	**$9.73**	**$10.03**	**$7.77**	**$8.70**	-------

Figure 5.5: Subject Rating and Valuation

Attributes	WEIGHTS		RATING
Shoreline	0.05	☒	5
Services	0.23	☒	5
View Aesthetics	0.33	☒	7
Apparent Naturalness/Privacy	0.05	☒	5
Location	0.34	☒	3
Composite Quality Index (CQI)	1.00		4.97
Size Adjustment Function (0=None)	-1.3		

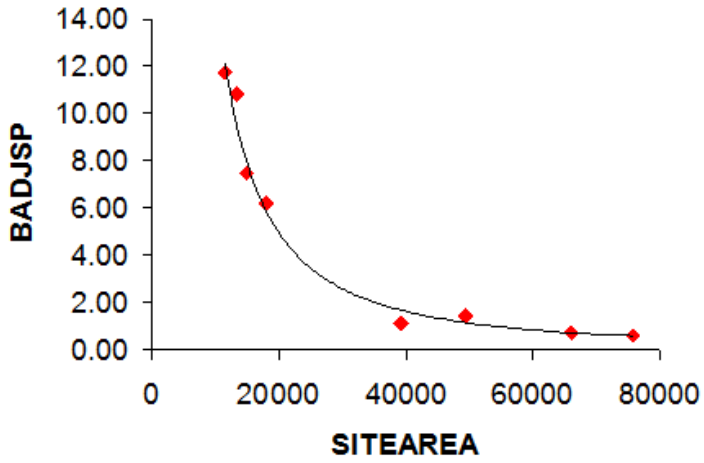
Model Summary & Subject Valuation			
Mean QADJSPP	1.82		
Standard Error QADJSPP	0.07		
COV	3.59%		
Site Area	13,200		
			PER SF
Point Estimate of Value	$119,000		$9.04
Value Range	$115,000	to	$8.72
	$124,000		$9.37

The following sections provide further explanation for this example and for QP in general.

Size Adjustment

Lot size is often the most important predictor of price, as was the case with the waterfront properties in this assignment. Figure 5.6 illustrates the non-linear inverse relationship between the baseline sale price per square foot (BADJSP, adjusted only for property rights, motivation, financing, and market conditions) and the parcel size for the eight comparables. We used Excel's graphic tools to search for a curve function that best fits this pattern. Not surprisingly, the observed data points closely track a "power curve" (non-linear exponential line, recall discussion from Lesson 3), which is imposed on the graph.

Figure 5.6: Plot of BADJSP against SITEAREA

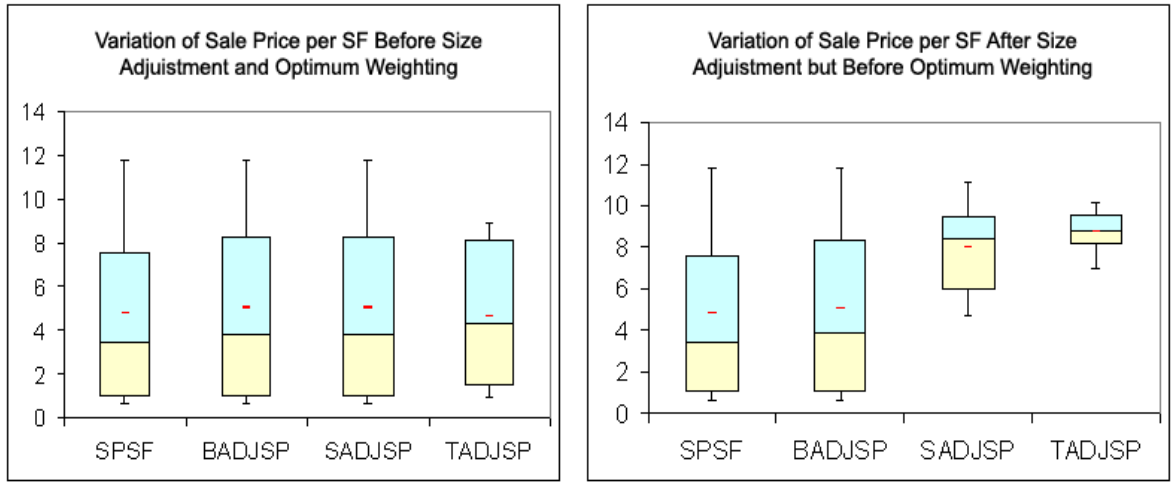


QP has a size adjustment function built in, allowing direct and automatic calculation of an adjustment factor for each sale, similar to using the logarithmic process illustrated in Lesson 3. The subject's size adjustment factor of -1.3 reflects the exponent in the logarithmic formula. Rather than solving equations directly, this adjustment is found in QP by backing into the answer through trial and error.[9]

[9] For a discussion of this approach to size adjustments, see Gene Dilmore, "A Program to Generate, Test, and select Land Size Adjustment Factors". *The Appraisal Journal*. April 1981. Instead of using his DOS program to implement the size adjustment procedure, here we instead used the QP.

Figure 5.7 provides boxplots illustrating the wide variation in price per square foot for the comparables before size adjusting (note the wide boxes in left boxplot), and then the dramatic decrease in variation of price per square foot after fitting an appropriate size adjustment to the sales (on the right boxplot, see the narrower box for SADJSP). Before size adjusting, the price per square foot range is $1 to $8 per square foot; the size adjusted value narrows this range to $6 to $9.

Figure 5.7: Variation of Sale Price per Square Foot: Effect of Size Adjustment



Quality Rating: Appraiser Judgment Required

In the qualitative portion of the analysis, we scored each property for the relative quality of its attributes and the scores were weighted for the contribution of each to sale prices. The outcome of this step was an overall measure of relative quality for each comparable sale. This "quality point" measure reflects the typical buyer's behavioural response to the attributes of the property.

When the subject property is independently scored and weighted in the same way, its ranked attributes can then be inserted into the sales array to determine their relative position on a quality scale. The weighted scores are descriptive of the magnitude of the differences, if any, between the sales and the subject. In summary, this price-quality valuation model is an attempt to simulate the thought pattern people use when purchasing property, in terms of ranking properties in comparison to one another.

The key to successful rating of the quality of specific sale attributes is consistency in applying rules. We identified five major attributes for waterfront properties and specified rules for them (see Table 5.1). In this case, each attribute was scored on a simple ordinal basis, a scale of 1 to 7, to represent a range of relative situations from poor to excellent. It is critical that the properties be rated accurately and consistently, or the outcomes will suffer (much as miscoded data can impair or destroy regression model results).

Attribute Weighting: How Solver Works

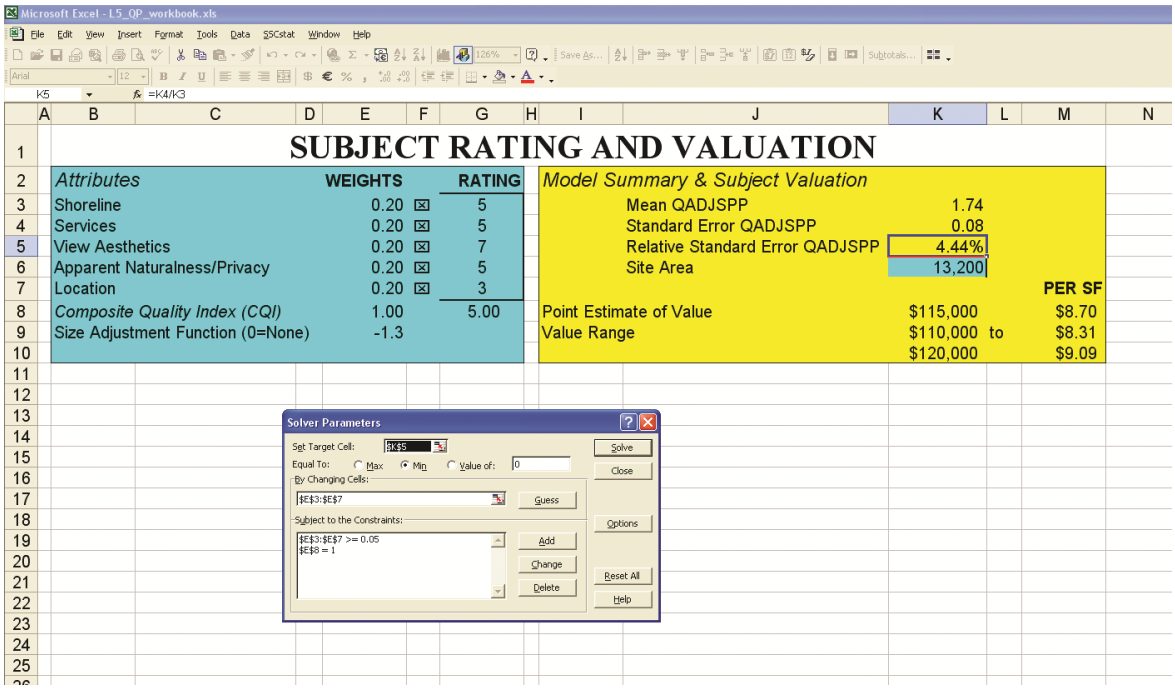
Once the appraiser has specified the quality ratings for each comparable's attributes and specified an initial weighting for a starting point (typically equal weighting for each attribute), then the QP sales comparison model's computing power takes centre stage. Figure 5.8 illustrates how Excel's Solver utility is programmed to select an optimum weight for each attribute. Essentially, it completes a trial and error process, where it tries a weighting, sees how well the resulting estimate matches the actual sale prices, and then repeatedly varies the weighting until it finds the optimal set of weights that minimizes the prediction error. In our example, the program computed that a property's value is best estimated by assigning 23% impact to services, 33% to view, and so on.

Solver solves for these weights using linear optimization, which is roughly analogous to least squares regression (although different mathematically).[10] The optimum combination of weights minimizes the dispersion of sale prices per point per unit about the mean price, and therefore results in the smallest coefficient of variation for these prices.

In appraisal terms, this weighting is a mathematical form of what appraisers do intuitively in a qualitative relative comparison/ranking analysis (e.g., list the attributes using a scale such as very inferior/ inferior/similar/superior/very superior, and then conclude an overall quality of each comparable relative to the subject, in order to bracket the subject's sale price). The main difference in QP is that it replaces this very subjective appraiser judgment with mathematical modelling. But, at their foundations, both approaches are similar in that they are attempting to reflect the importance of each property's attributes from the perspective of market participants.

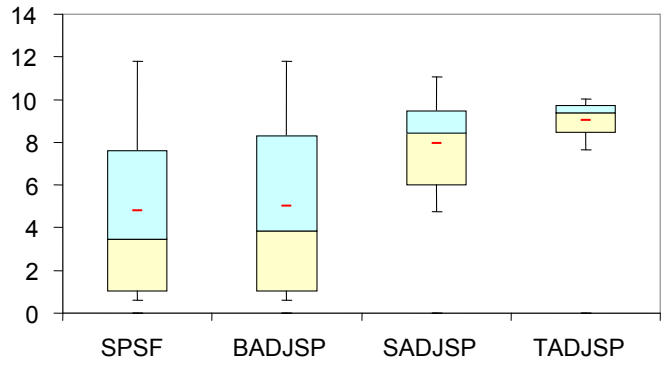
Figure 5.9 shows the variation in sale price per foot after all quantitative and qualitative adjustments have been carried out. You will note it looks very similar to Figure 5.7, confirming that the size adjustment explained most of the price variation for these sales. Optimizing the weights did help reduce variation, but the effect was not great in this instance.

Figure 5.8: Excel's Solver Utility



[10] The QP readings on the Course Resources webpage provide more explanation of this process, the meaning of optimum, and the instructions that are given to the Solver utility to accomplish the objective.

Figure 5.9: Variation of Sale Price per Square Foot After All Quantitative and Qualitative Adjustments



Reconciliation of Estimates

As with traditional sales comparison, each of the comparable's adjusted sale prices is a possible value indication for the subject property. Therefore, a reconciliation process must be applied in QP as well. Much like traditional appraisal, the appraiser may be tempted to rely on the mean of these adjusted sale prices. However, here too this may be poor valuation practice, because it implicitly assumes all eight comparables are equally similar to the subject.

Instead, the appraiser should apply judgment based on deductive reasoning in reconciling the values. For example, you might decide LF3 and LF6 are the most similar to the subject and are the best indicators at $1.85 and $1.96 per quality point per square foot; from this, you could conclude that the final value for the subject should lie between those values. Or perhaps you may find some other conclusion, but the point is that the appraiser must now step away from the statistics and apply his or her expert valuation opinion.

Reconciling Quality Point with Direct Comparison Approach

While the calculations carried out in Quality Point may seem bewildering at first, when boiled down it is simply a variation on the familiar ranking and relative comparison techniques in a qualitative direct comparison approach. In effect, the main difference is that in a traditional qualitative approach the appraiser "eyeballs" the data array and informally makes comparisons using word or symbol descriptors and subjectively weights the attributes, while in QP, the comparisons are made on a numerical scale and software does this weighting based on mathematical relationships.

A difficulty students have with QP is equating the concept of the "composite quality index" with reality: if you have a house that needs appraising, how can you explain a "quality point" to a client or layperson? In effect, the quality point provides a ranking of the subject's overall quality compared to the sale comparables. It is analogous to asking "what is the relative quality of the subject on a scale of 1 to 7?" Here, the subject's quality point or CQI is 4.97, which puts it in the middle of the range of 3.07 to 6.32 from the comparables, and closest to LF3 and LF6 at 4.77.

As a final example, we want to see how well the quality point/CQI stacks up against actual sale prices: does the quality ranking actually relate to value? As a descriptive tool only, we examined a regression of size adjusted sale price against CQI to see the relationship. Figure 5.10 shows an R-square of 0.889, which indicates 89% of the variation in sale price for these eight comparable sales is explained by our quality ranking. That is a very good result!

Figure 5.10: Regression Results for Quality Index Against Sale Price

Data set = waterfront, Name of Fit = L1
Normal Regression
Kernel mean function = Identity
Response = SADJSP
Terms = (CQI)

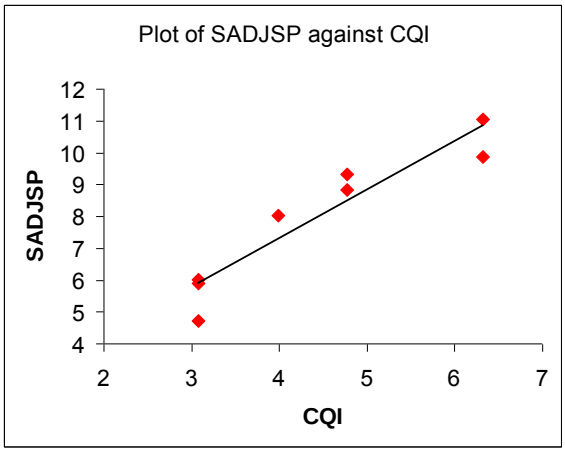
Coefficient Estimates

Label	Estimate	Std. Error	t-value	p-value
Constant	1.20597	1.01184	1.192	0.2783
CQ	1.52860	0.219781	6.955	0.0004

R Squared:	0.889652
Sigma hat:	0.794022
Number of cases:	8
Degrees of freedom	6

Summary Analysis of Variance Table

Source	df	SS	MS	F	p-value
Regression	1	30.4981	30.4981	48.37	0.0004
Residual	6	3.78283	0.630472		
Lack of fit	2	1.9358	0.967901	2.10	0.2384
Pure Error	4	1.84703	0.461757		



Implications of Case Study

In this appraisal assignment, there was considerable opposition to the renewal rents established from these appraisals. However, the opposition dissipated quickly after the presentation of the above model; in the end, the tenants did not pursue arbitration. We hope this case demonstrates the power of statistical and computer modelling when integrated with traditional but well-grounded valuation theory and methods. We suggest this highlights that there is still room for innovation and new applications in contemporary appraisal practice.

In summary, this case illustrated an alternative approach to qualitative adjustment methods in the direct comparison approach. We showed how QP's price-rating technique combines statistical methods, data exploration, and appraisal foundations with software and computing power. The result can be a more efficient method together with more supportable and defensible appraisal conclusions. QP uses what appears to be advanced statistical procedures, but at its foundation it is simply attempting to more closely replicate buyers' shopping behaviour.

A weakness of QP is that it requires significant judgmental forecasting in terms of consistent application of quality ranks (although this is a similar weakness of traditional direct comparison methods). When using the Quality Point technique, or any advanced methods, it is critical to point out the weaknesses as well as the strengths, so that clients may make an informed decision about the reliability of the final valuation outcomes.

Quality Point Exercise

Figures 5.4 and 5.5 in this case illustrated a Quality Point calculation in Excel. We have provided a working copy of this spreadsheet on the course website, under "Online Readings". You may open this spreadsheet and "play" with the numbers to see how changes affect the QP valuation.

Notes on this file:

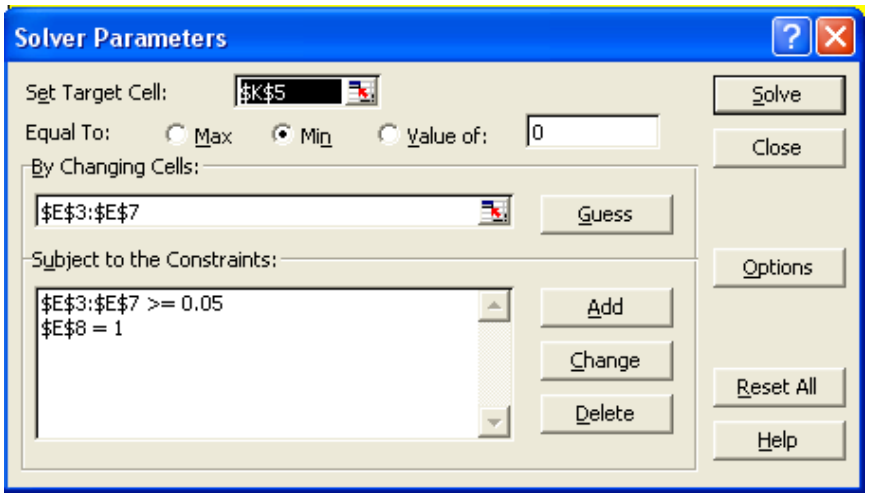
QP uses Excel's Solver add-in utility, which you can find under Excel's Data tab (or Tools menu on older versions of Excel). If you do not see Solver, then you need to install it into Excel. Click the Office Button → Excel Options → Add-Ins, and select Solver Add-in from the list (or choose Tools → Add-Ins, and select Solver Add-In from the list). If Solver isn't in the list, you will need to install it by running the Office Setup program from the CD again and selecting Solver from the list of Excel add-ins.

In this file, we have locked the yellow cells to ensure you do not accidentally erase the formulas. However, you can still observe the formulas in the locked cells. The boxes in blue can be changed, so you can experiment with altering numbers and see the effect on the valuation.

There are two types of "what if" exercises you are encouraged to perform with this QP template.

1. Value a new subject property. This assumes that the model is fixed and the sales on the sales grid are all comparable to the new subject. On the Subject worksheet, you first rate the subject attributes according to the rating rules (blue box) and insert the subject Site Area (blue cell in yellow box). The spreadsheet recalculates automatically.

2. Revise comparables. Switch to the Sales Grid worksheet and then alter the ratings, sizes, and price details of the sales. Once that is done switch back to the Subject worksheet and recalculate the weights by running the Solver utility and observe the results. (to run solver it is under the Data tab, Analysis, or under the Tools menu; the parameters are shown below).



Case Study 7: Everglades – Selection of Appropriate Adjustment Variables

The focus of this case study is the use of multiple-regression analysis (MRA) for analyzing valuation-related data.

The key points are:

- Gaps or flaw in the integrity of any of the steps in the real estate research process, including data gathering, exploration, and subsequent analysis, can lead to biased or in this case, incomplete outcomes.
- Data by itself is not useful information. Useful information is what results from critically analyzing data for reliability and relevance, then organizing and interpreting that data to become information.
- Regression analysis is an analytical tool which can help us understand market relationships, for example, the delineation of various sub-markets and the market variables having the strongest correlation with market value.

In this case study, we will review a statistical analysis used to determine key value attributes for Florida wetlands. The 1997 case study is based on a consultant's report intended to help appraisers with property and rights acquisition activities for a flood control project. One interesting aspect of this case is that the preliminary results were found to be flawed and a subsequent consultant's report was necessary in 1999 to reflect the impact of additional sales not considered in the initial study.

The case study can be found on the course website under "Online Readings". We will provide an overview of its key facts and findings here.

Case Overview

In 1997, the US Department of Justice commissioned a study to determine key variables impacting the value of South Florida wetlands. The Corps of Engineers (Corps) and the National Park Service (NPS) were to acquire approximately 300,000 acres, in order to expand the Everglades National Park and the Big Cypress National Preserve, as well as re-doing the plumbing of the L31-N Canal to recharge, rather than drain, the Everglades. They retained the firm Pritchett, Ball, & Wise, Inc. to give appraisers uniform guidance on the market variables which appeared to have the most influence on property market value.

Given an acquisition project of this magnitude, the federal agencies wanted consistent direction for selecting value comparables and adjustment processes, to ensure uniformity in valuation methodology and overall fairness for the acquisition process. The uniformity of approach is often an issue with large-scale land or rights acquisition projects since authorities often deal with a number of local appraisal professionals rather than one or two large firms. In addition, having each firm conduct this research independently would be inefficient and add excessive project costs.

Data Collection and Verification

The authors began with a database of 2,500 comparable sales gathered from appraisals of these wetlands over the past twenty years for the Corps, the NPS, the South Florida Water Management Agency, and other governmental or quasi-governmental agencies. They found a number of these were duplicate sales where reports had relied on the same transactions. The data analysis was also complicated by sale price anomalies, given the unique property type and non-typical motivation of parties. Examples of anomalies included very high or very low sale prices, and non-local purchasers who were uninformed about the restricted use of the wetland properties.

The consultants completed a rigorous review of data integrity for each recorded sale. The authors recorded all of the qualitative data they could on each parcel from each appraiser's comments, reconciled conflicting information as best they could, re-verified the transaction data with either the buyer or seller, geocoded the data, and flew to inspect each parcel. To reduce bias, they restricted their interviews to only buyers and sellers who had seen the sold properties. The verification process resulted in a refined dataset for the Everglades of 362 sales and 360 sales for the Big Cypress region. In addition, the evidence pointed to price per acre as the optimal unit of comparison (dependent variable) and a total of 177 potential independent (explanatory) variables.

Data Transformation and Analysis

Three analytical tools were used:

- Statistical Analysis
- Paired Sales Analysis
- Qualitative Analysis (Judgemental Forecasting)

The *statistical analysis* was completed in SPSS, using stepwise multi-linear regression model at a 0.05 significance level. A number of qualitative variables required data transformation into binary or numeric variables (e.g., convert location quality to a numerical rank). The stepwise regression reduced the potentially correlated independent variables from 177 to 11. Analysis of the regression model's residual error showed outcomes within statistically acceptable parameters.

The *paired sales analysis*, following traditional valuation methodology, was an attempt to isolate the specific influence of variables by comparing two sold properties where the only difference was the influence of a single market variable. The consultants acknowledged the difficulty in finding sets of similar or almost identical properties that differed only in the market factor under consideration. They noted how judgment was required to identify which variables were most likely to influence sale price. After a series of tests, they concluded the paired sales analysis could not be credibly completed due to insufficient sales and too much variability in the market data.

The consultants also used a form of *qualitative analysis* to help determine which explanatory variables were most likely to influence the sale price of wetlands. From interviews with appraisers, local property owners, brokers, government staff, and documentary research, they concluded at least eight variables to be considered when valuing property in the east side of the State (Everglades) and 12 variables for the west side. The qualitative analysis results were used as a reasonableness test to support the regression analysis findings.[11]

Implications of Case Study

The 1999 report on the website is a revision of their original findings, after reviewing important data omitted in the 1997 study. The 1997 study excluded sales that exhibited "project influence", or impact of government action on value, because the original appraisal reports generally excluded these sales (in accordance with the federal and state valuation guidelines). As a result, the 1997 study did not accurately test project influence as a possible adjustment variable. This was revised in the 1999 study.

This accidental oversight, brought to the attention of the study's authors by the U.S. Department of Justice, demonstrates the importance of critically exploring data before analysis to support value conclusions (emphasized in Lesson 3). A crosstab analysis of sale locations in the Everglades may have shown that few sales were located in areas where the government had acquired land, perhaps triggering the question "why were there no sales in these areas?" The results would have uncovered that the "project influenced" sales discarded within the appraisals actually formed an important part of the database for the study. While "project influence" was found to not be a major adjustment variable, its use as a filter on sales had detracted from the original conclusions. The

[11] The analysis used forecasting techniques that are highlighted in the UBC Real Estate Division course BUSI 460 *Critical Analysis and Forecasting in Real Estate*. Those interested in learning more may wish to continue on to BUSI 460.

revised study included 173 additional sales. It is worth pointing out that not all possible sales were included in the study, but in the end they focused on a statistically significant sample size that is accurate 19 times out of 20 (2 standard deviations either side of the mean).

The consultants concluded that 11 variables had the greatest influence on sale price. Examples of these variables included sale financing, location, land use regulations, road access, and agriculture potential. The advantage of the regression analysis was that it provided a quantitative measure of each variable's relative strength (coefficient) in explaining variation in property sale price. However, consider whether the consultants' approach to specifying the regression model (177 initial variables) was excessively complex. What impact might the complexity of this approach have on the understandability and credibility of the final conclusions? Could appraisal judgment have been used to reduce the number of variables tested in step-wise regression?

One potentially unexpected outcome was the failure of the traditional appraisal "paired sales analysis" to yield useful information about multivariate relationships. A lesson for appraisers is to exercise caution in application of analytical techniques. It is important to match methodology with the appraisal problem to be solved. Statistical analysis is particularly well-suited for consulting assignments involving large datasets.

In reviewing regression analysis findings it is crucial to understand that a correlation between dependent variable (price per acre) and independent variables does not imply causality. The analyst must use judgment to analyze and assign causality. For example, consider one group of sales showing an inverse price to size relationship (group 1) and a second group showing price per acre as a constant regardless of size (group 2). The analyst must determine why one group differs from the other. The analyst might discover that each group 1 sale only has utility as a site for one single family detached dwelling, and consequently larger size produces little added value. On the other hand, the analyst might discover that each group 2 sale is farmland wherein each additional acre has intrinsic value in allowing additional crops to be grown. The statistics show correlation, but the analyst must conclude causality.

In summary, this case study highlights the importance of identifying the type of data that you expect to find, and questioning why it is unavailable if you do not find it. The case study offers a practical example of using step-wise regression to help solve a valuation problem that might prove extremely difficult otherwise, given the large amount of non-homogeneous data available. The property under review was a complex one in that much of the land is under water for part of the year (as stated on page 9 of the study). Consider the application of this methodology to similar land and rights valuation projects in Canada, such as rental review of leased property within the National Parks or acquisition of a right-of-way for a mass transit project, such as the Canada Line (Sky-Train extension) in Vancouver or the proposed Ottawa Light Rail Transit project.

Summary

This lesson has covered several examples of how statistical analysis and computer applications can be used advantageously in real estate practice. Each case study highlighted an example of a practitioner applying creativity and ingenuity in resolving a real estate-related problem. The cases were intended to emphasize how statistical concepts are useful in everyday work, often to carry out a type and quality of work that would not otherwise be possible. Our hope in developing this course is that practitioners might be better equipped to address client needs productively, improving their work effectiveness and job satisfaction, as well as solidifying their competitive advantage.

Of course, keep in mind that we have only brushed the surface of what is possible in this area – new innovations are continuously being discovered and developed (as they say, "the only constant is change"). We encourage readers to seek out further applications on their own beyond the course. Interested students may wish to review the "Online Readings" on the course website as a starting point for more research on this topic.

In the next lessons, we will continue our exploration of statistical and computer applications in valuation, specifically how regression can be used to value multiple properties at once.

The seven case studies covered in this lesson are summarized below:

- Case Study 1: Using a simple methodology to determine a probable value range, a time adjusted estimate of value, and a possible need for adjustments.
- Case Study 2: The power of collecting your own data and visually analyzing it. These concepts were applied to single family residential price trends.
- Case Study 3: The use of graphical analysis and a non-linear trend line to determine size adjustments
- Case Study 4: Using natural logarithms to create a linear relationship between two variables
- Case Study 5: Similar to Case Study 3, the power of collecting and maintaining your own database and visually analyzing it; applied here to rental rates for commercial property.
- Case Study 6: Use of the Quality Point adjustment methodology to value property.
- Case Study 7: Demonstrating the use of multiple regression analysis in valuation, but stressing the importance of thorough preliminary data analysis.

Review and Discussion Questions

1. In Case Study 1, the author has used median rather than mean. Would the mean have been more appropriate for this analysis? Provide the rationale for your answer?

2. Case Study 2 addresses acceleration and deceleration of market demand for single family detached dwellings. In your own words, explain this concept and whether or not you agree with it as a helpful tool for market analysis.

3. In Case Study 5, graphical analysis was used to verify judgmental forecasts of rents applicable for a specific sub-market area (Fort Street). Can you see any limitations with this graphical analysis?

4. What is graphical analysis? List some applications of graphical analysis in property valuation.

5. Consider Case Study 7. How did the consulting team improve the understanding and credibility of the methodology for their clients? Do you feel this was effective?

6. Case Study 7 employs regression techniques that apply the coefficient of determination (R^2) and the standard error of the estimate. Can you see any weaknesses in these case studies where excessive reliance was placed on one or two statistics, such as R^2 or the SEE?

7. In Case Study 1, a sales indexing approach was used to provide a preliminary indication of the value range for a property which is appraised. Can you see any scenarios in which this approach might not work or lead to unexplainable outcomes?

8. Which statistical tools applied in these case studies do you think you are most likely to use in your future assignments? Why?

9. Your client, the Vancouver International Airport Authority (YVR) in Richmond, BC, is conducting a rent review of a major flight services tenant, Air Peebles. However, YVR and the tenant cannot agree on the market rent and both parties have agreed to accept the decision of an independent commercial lease arbitrator on the appropriate new minimum base rent lease for the next lease term, beginning January 1, 2009. Your valuation consulting firm has been selected for this assignment by the parties after a proposal call process managed by the lease arbitrator.

   The goal is to determine the market rent for land occupied by the tenant, using direct comparison approach valuation methodology (DCA). You will need to illustrate the use of statistical methods in applying the DCA, drawing upon lesson material in the Lesson 4 and 5 case studies. Locate the files "Airport" in the "Online Readings" section of the website to get the full description of the exercise and the data.

ASSIGNMENT 5

LESSON 5: Statistical Analysis and Computer Applications Case Studies

Marks: 1 mark per question.

1. Refer to Case Study 1. Suppose the median sale price of a typical condominium apartment in this neighbourhood is $250,000, the sale price range is $210,000 to $290,000, and the typical unit is 1,000 square feet. You are appraising a unit that sold for $220,000 for mortgage financing purposes. Which of the following statements may explain the sale price for the subject property, prior to your inspection and detailed analysis?

   (1) It may be in poorer condition than the typical unit in this neighbourhood.
   (2) The subject unit may be located on the ground floor and north side of its building.
   (3) It is likely smaller than 1,000 square feet and will likely have a market value greater than $250 per square foot.
   (4) All of the above.

2. Refer to Figure 5.1: *Single Family Dwelling Price Trend – Year to Year* in Case Study 2. What was the approximate average monthly acceleration rate from July 2001 to September 2004?

   (1) 2.75% per month
   (2) 0.5% per month
   (3) –0.5% per month
   (4) 21% per month

3. Refer to Figure 5.1: *Single Family Dwelling Price Trend – Year to Year* in Case Study 2. Based on the median, what was the approximate monthly deceleration rate from January 2007 to December 2008?

   (1) 8% per month
   (2) 0.8% per month
   (3) 1.6% per month
   (4) -0.8% per month

4. Refer to Figure 5.1: *Single Family Dwelling Price Trend – Year to Year* in Case Study 2. Based on this graph, if this is December 2003 and you are a residential subdivision developer, which of the following is the most reasonable conclusion you could reach from this?

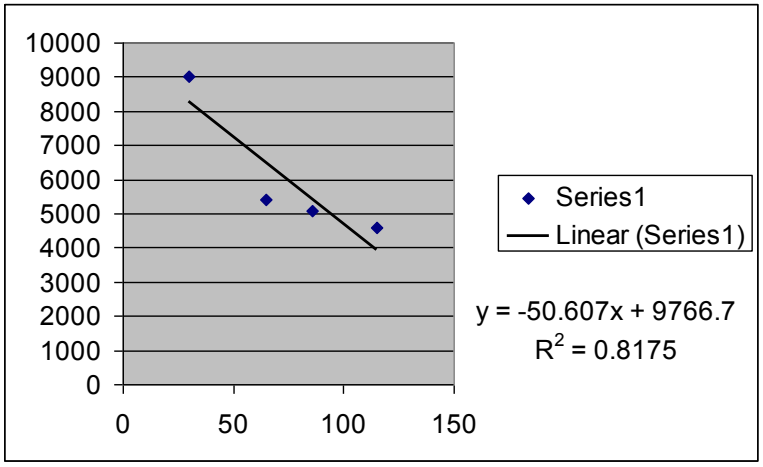
   (1) Demand is levelling after a two year period of acceleration. It has been a good run, but now it is time to sell off my remaining lots and invest in stocks.
   (2) These statistics look promising for starting a new subdivision, but I'm going to have to provide a supporting opinion on the state of the market before proceeding with a project.
   (3) Demand is accelerating. Starting a large new development is a "can't lose" proposition.
   (4) Statistics can lie. I'm going to ignore this information and trust my own instincts.

Assignment 5 continues on next page

5. Case Study 3 provides a logarithmic trend line to reflect the non-linear relationship between the dependent variable, price per acre, and the independent variable, lot size. You are appraising the value of a 20-acre subject property, recognizing that some interpolation will be required. Which of the following would be the closest price/acre adjustment factor for a 40 acre comparable sale, to make the property more similar to the 20-acre subject?

(1) (5,300 – 6,800) / 6,800 = –0.22 (–22%)
(2) (6,800 – 5,300) / 5,300 = +0.28 (+28%)
(3) (5,000 – 5,800) / 5,000 = –0.07 (–7%)
(4) (20 – 40) / 40 = –0.5 (–50%)

6. Refer to the first table of Case Study 3, showing a price per acre range of $4,600 to $9,000. The following is a scatterplot of price per acre against lot size in acres for this data, with a linear equation imposed.



What can you conclude about this relationship?

(1) A visual inspection indicates a good fit, with the data clearly showing a linear pattern.
(2) The negative slope indicates that eventually the straight line will intercept the x-axis and price per acre will be zero, a pleasant but impractical concept.
(3) Based on this equation, a 200 acre lot should have a value of –$354.70 per acre.
(4) Both (2) and (3) are correct.

7. Consider a linear equation of price per acre against lot size in acre, with a slope of –471.52 and y-intercept of 7,593.3. An 8 acre comparable sale plotted on the graph shows price per acre of $3,800. If the subject size is 6 acres, what is its indicated price per acre (rounded to nearest $100)?

(1) $5,100
(2) $6,500
(3) $4,800
(4) $7,600

Assignment 5 continues on next page

8. Refer to the first table of Case Study 3, showing a price per acre range of $4,600 to $9,000. Based on the R-square of its logarithmic trendline, what percentage of the change in sale price per acre is explained by changes in lot size? *Hint*: See footnote in Case Study 3 for how to create a logarithmic trendline. You will be using the four numbers in the two columns "Area(Acre)" and "Price/Acre".

(1) 35%
(2) 62%
(3) 81%
(4) 94%

9. Can statistics *prove* correlation, causality, both, or neither?

(1) Causality
(2) Correlation
(3) Both
(4) Neither

10. Which of the following must be confirmed by the analyst rather than by statistical outcomes?

(1) Causality
(2) Correlation
(3) Both
(4) Neither

11. Refer to Figure 5.3: *Retail Rents* in Case Study 5. Based on this graph, what is the approximate range per square foot of operating costs in the 800 block of Fort Street? *Hint:* Operating costs are the difference between gross and net rents.

(1) $12.00 to $20.00
(2) $6.00 to $8.00
(3) $18.00 to $31.00
(4) $5.00 to $6.00

12. Refer to Figure 5.3: *Retail Rents* in Case Study 5. Based on this graph, which one of the following blocks on Fort Street has the highest per square foot operating costs?

(1) 1000 block
(2) 600 block
(3) 800 block
(4) 900 block

Assignment 5 continues on next page

13. Refer to Figure 5.3: *Retail Rents* in Case Study 5. Based on this graph, what can you conclude about the rents for the 800 block of Fort Street?

(1) The largest unit has the lowest rent per square foot.
(2) Rents are on average lower than in the 600 block, showing that distance from city core tends to reduce rents.
(3) The slight upward curve at the 1000 block may indicate some feature that is attractive to commercial tenants in the 1000 block, compared to the 800 block.
(4) All of the above are true.

14. In Case Study 6, the Quality Point method is used to adjust the sales comparables to the subject property. In which of the QP steps is there the most potential for significant appraisal bias?

(1) Identification of appropriate units of comparison through correlation analysis.
(2) Use of the Excel Solver utility to identify the optimum weighting.
(3) Development of rating rules for each of the remaining qualitative adjustment factors.
(4) All of the above are equally likely to bring bias into the analysis.

15. Prior to adjustment, the four indices show prices per acre of $9,000, $5,400, $5,100 and $4,600. After adjustment the prices per acre are $7,700, $6,500, $6,800 and $7,700. What are the respective standard deviations of these two samples of data?

(1) $1,998 and $577
(2) $2,027 and $523
(3) $2,011 and $618
(4) $1,400 and $325

16. Given the results in the question above, what can you conclude about the process undertaken in Case Study 3?

(1) The visual analysis for size adjusting non-linear data did not work. A logarithmic transformation must be carried out.
(2) The visual analysis for size adjusting non-linear data appears to have reduced the market value range.
(3) Standard deviation is just a number, the analyst must prove causation.
(4) None of the above; all the statements are incorrect.

17. Which of the following statements is FALSE regarding Quality Point (as we have applied it in Case Study 6)?

(1) CQI is unrelated to sale price.
(2) Properties must first be quantitatively adjusted to a consistent baseline for comparison.
(3) QP may be able to "mine" deeper into data, uncovering hidden or uncertain relationships in sales data.
(4) Linear optimization is roughly analogous to the process in multiple regression, although mathematically different.

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18. What is an advantage of using the neighbourhood level statistical analysis, as shown in Case Study 1?

(1) By analyzing more data than the typical direct comparison approach, the appraiser can help avoid skewed value estimates due to insufficient data.
(2) The resulting price per square foot may serve as additional support for the value estimate.
(3) Even before the direct comparison approach is undertaken, the analyst has a degree of confidence about the value range.
(4) All of the above are correct.

THE FOLLOWING TWO QUESTIONS RELATE TO THE BUSI 344 PROJECT 1 DATABASE CALLED "CONDOSALES". PLEASE DOWNLOAD THE PROJECT 1 FILES FROM THE ONLINE READINGS ON THE COURSE RESOURCES WEBPAGE.

19. Calculate the mean, standard deviation and COV for the Sale Price, the Sale Price per Square Foot and the Sale Price per Bedroom. Based on these statistics which variable has the tightest distribution and would make the best unit of comparison?

(1) Sale Price because it has the mean with the greatest value and a COV that is less than 30%.
(2) Sale Price per Square Foot because it has the COV with the least value.
(3) Sale Price per Bedroom because it has the COV with the greatest value.
(4) The Sale Price per Square Foot and the Sale Price per Bedroom have equally tight distributions, either one would make a good unit of comparison.

20. The New Construction variable is binary – either "Y" for new construction or "N" for older. As you did in Lesson 3 Question 19, use the Year Built variable as a guide to fill in the missing values of the New Construction variable; and then use the Unit Number variable to fill in the missing Floor Number. After those changes have been made, split the "condosales" database by the New Construction variable (use Data → Split File). Run a box plot of Sale Price per Square Foot versus Floor Number. Which of the following statements is TRUE?

(1) For sales with New Construction = "Y", as the Floor Number increases, there is an increase in the median Sale Price per Square Foot.
(2) For sales with New Construction = "N", the median Sale Price per Square Foot for Floor = 1 is at least $50 less than the median Sale Price per Square Foot for the other three floors.
(3) Floor Number appears to have little impact on the Sale Price per Square Foot whether the New Construction variable is equal to "Y" or "N".
(4) Both (1) and (2) are TRUE.

20 Marks

Planning Ahead

Project 1 requires you to submit a written valuation project based on Lessons 1-5 and is due on the same date as Assignment 7, two weeks from now. You should be well into the work required for this project by now. The Case Studies covered in Lessons 4 and 5 should be helpful in providing ideas for methods to use in your analysis.

End of Assignment 5