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Regression Analysis

Use & Misuse in the Calculation of Disturbance Damages

Presentation to
British Columbia Expropriation Association
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Presenters

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Presentation Overview

- What is regression analysis?
- How is regression relevant to expropriation compensation?
- Example of the use of time series regression.
- Example of regression analysis using comparable sales data.
- Summary.

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What is Regression Analysis?

- Regression analysis is a mathematical tool which measures how well one set of numbers predicts another.
- In simple linear regression, there is a linear relationship between the sets of numbers.
  - This means that the graph of these numbers almost forms a straight line.
  - It also means that the sets of numbers are related by a linear equation.

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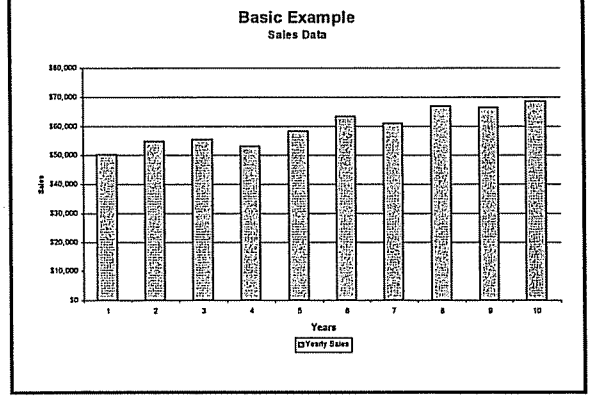

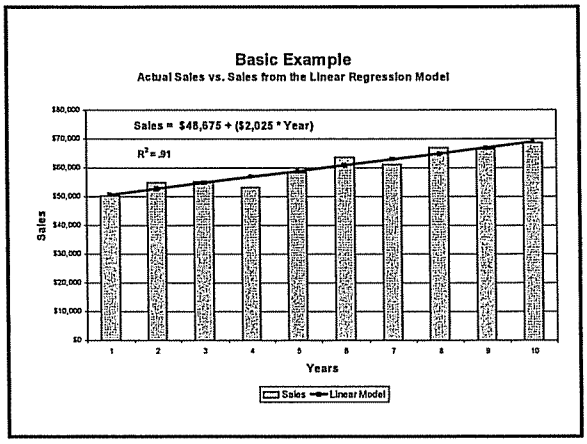

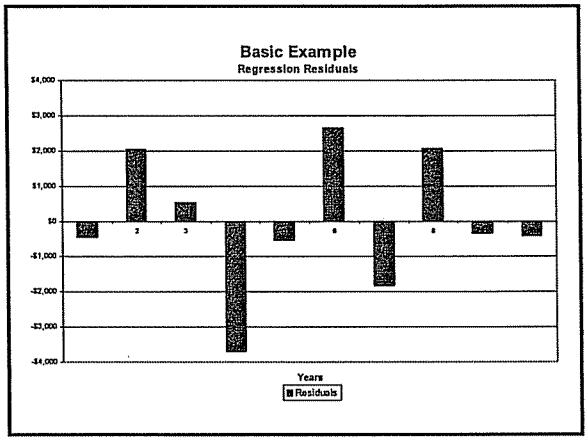

Is the Linear Model Appropriate?

- Does the model data give a good fit graphically?
- How much of the variation in the data does the model explain? The quantity R^2 gives the percentage of variation explained by the model. In our example, the model explains 91% of the variation.
- Are the residuals random? (In our example, they are.)
- Are the magnitudes of the residuals reasonable?
- Does the model make sense from a business point of view?

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Relevance of Regression

- On the expropriation of a property occupied by a business, the expropriating authority must compensate an owner for resulting financial losses.
- One component of the business loss may be disturbance damages resulting from the taking (and related works).
- Business disturbance damages are calculated as the difference between the business's actual income and its hypothetical income, if not for the taking.

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Relevance of Regression Analysis

- Example of loss of earnings calculation

	Consequential Loss of Earnings		
	Unaffected	Actual	Loss
Sales	$1,400,000	$900,000	$500,000
Cost of sales	-910,000	-585,000	-325,000
Gross profit	490,000	315,000	175,000
Expenses	-168,000	-108,000	-60,000
Earnings	$322,000	$207,000	$115,000

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Relevance of Regression Analysis

- Regression analysis is primarily used to calculate "unaffected" revenue – i.e., what would sales have been if not for the taking.
- Regression may be used to predict sales directly, or may be used to predict factors resulting in sales – such as litres of fuel pumped, number of customers served, number of rounds of golf played, etc.

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Example I – AgroSales Corp.

- AgroSales is a supplier of agricultural products. It operates from a commercial building located on a major highway.
- As the result of a full taking, in July 1998, AgroSales relocated its business in alternate premises.
- AgroSales is claiming that the disruption caused by the move resulted in a reduction in its sales and a loss of profits.

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Example I – AgroSales Corp.

- The first task in determining the consequential loss is to gather sales data for the business.
- Graphical presentation is used to gain a better understanding of sales trends.

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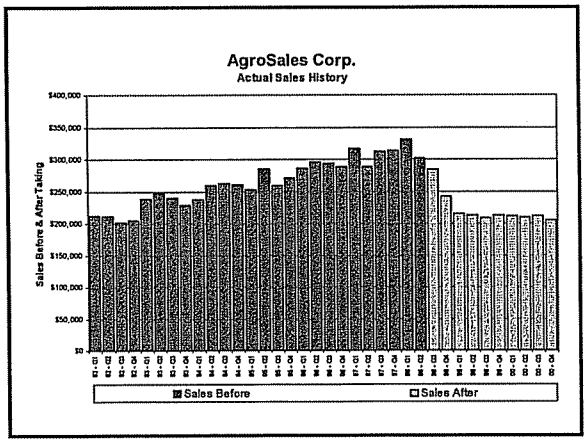

Example I – AgroSales Corp.

- From review of the graph, it is obvious that something happened in mid-1998 which resulted in a decline in sales.
- One basis upon which unaffected sales may be estimated is to assume that, if not for the taking, the trend of sales prior to the taking would have continued.
- Can time series regression will be used to estimate unaffected sales?

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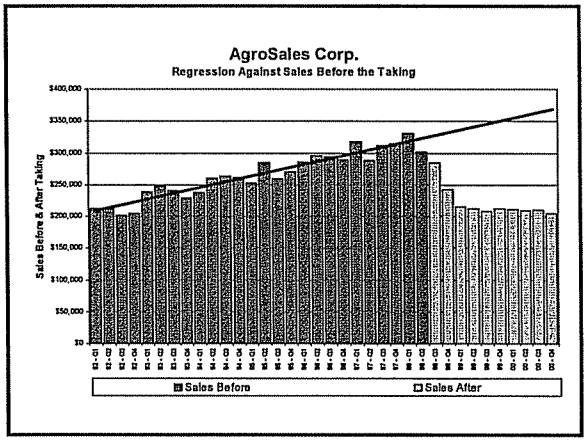

Example I – AgroSales Corp.

- The linear model based on the 26 quarters before the taking is:
  Sales = $203,659 + ($4,583 x Period #).
- The model fits very well graphically and the model explains 90% of the variation, that is, $R^2 = .90$.
- A careful examination of the residuals indicates the model fits well.
- Does the model make sense from a business point of view?

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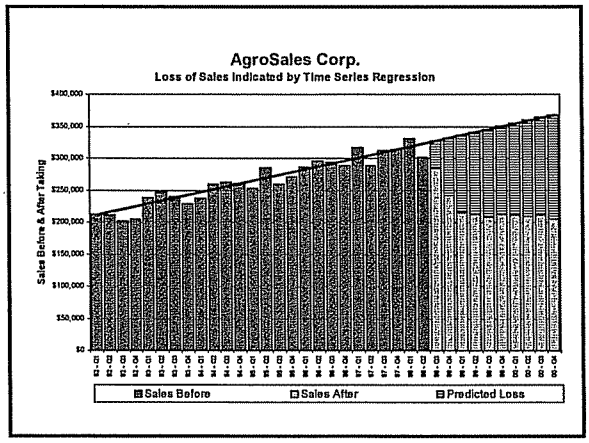
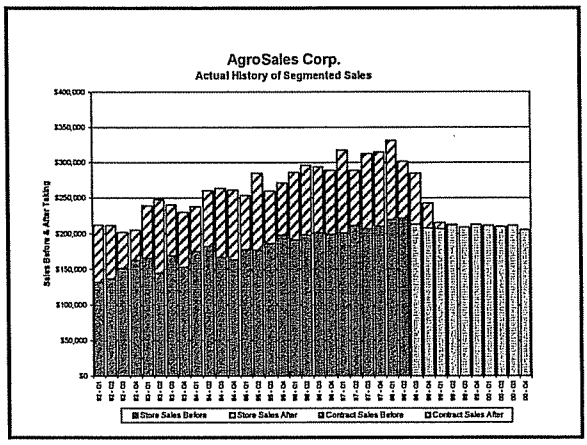


Example I – AgroSales Corp.

- Based on time series regression analysis, sales loss is estimated to be approximately $1.2 million during the 30 months following the taking.
- It appears that the business did not recover – i.e., is there a claim for "permanent" damage to the business?

Example I – AgroSales Corp.

- Considering the nature of the AgroSales business, the extent and severity of the loss does not appear reasonable in relation to the disruption caused by the move. Is there another cause for sales decline?
- More in-depth analysis indicates that AgroSales operates two divisions – a retail store and an contract supply business. While the store business was adversely impacted by the move, the move had no impact on the contract supply business.
- Graphing segmented sales provides a different outlook.



Example I – AgroSales Corp.

- We now find out one of the shareholders left the business, taking the contract sales division with him. The decline in contract sales is not a consequence of the taking.
- Time series analysis is applied again, this time to estimate the consequential reduction in store sales.

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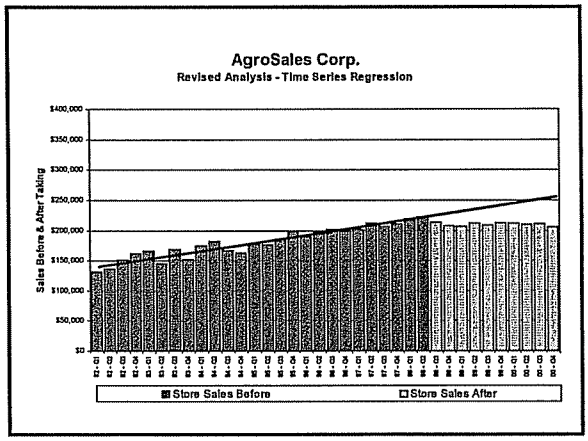

Example I – AgroSales Corp.

- The linear model for store sales based on the 26 quarters before the taking is:

  Store Sales = $137,891 + ($3,174 x Period#)

- Again, the model fits very well graphically and the model explains 91% of the variation in the sales data, that is, $R^2 = .91$.
- An examination of the residuals again indicates that the model is appropriate.
- Does the model make sense from a business point of view?

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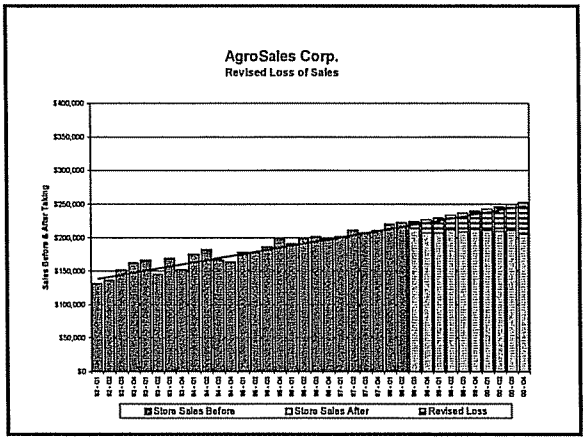

Example I – AgroSales Corp.

- Based on revised time series regression analysis, sales loss is estimated to be approximately $280,000 during the 30 months following the taking.
- Still appears that the business did not recover.

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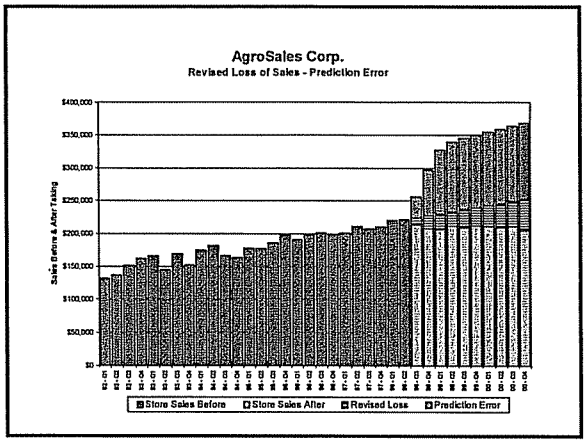

Example I – AgroSales Corp.

- Failing to properly define the data caused us to over-estimate the sales loss by almost $1 million.
- The second loss of sales projection may or may not be accurate. We need to look at the business reasons why sales declined. Were their events in the market or in the market, other than the taking which may have caused declined?

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Example II – Coffee Corp.

- Coffee Corp. is a retail coffee shop, located on a commercial strip in a major city.
- While only a small strip of land at the front of the property was expropriated, 8 months of road construction in front of the business caused traffic jams and impeded access to the business.
- Coffee Corp. is claiming that the disruption caused by the "related works" resulted in a reduction in its sales and a loss of profits.
- Sales are graphed to see if there is any obvious adverse affection.

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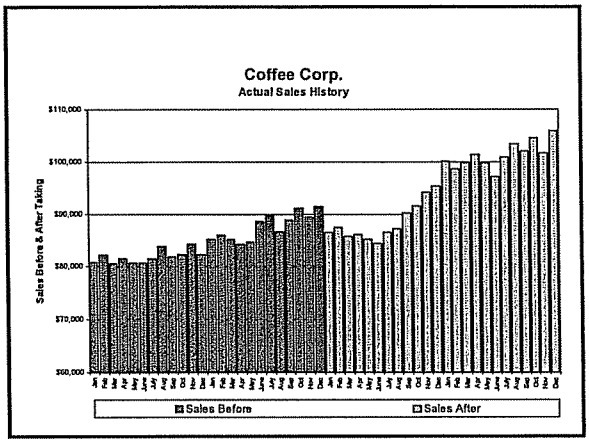

Example II – Coffee Corp.

- It is apparent that sales declined during the 8 months of road construction.
- Our first approach is to use time series regression to estimate unaffected sales This time we are careful to make sure that we have the right data set.

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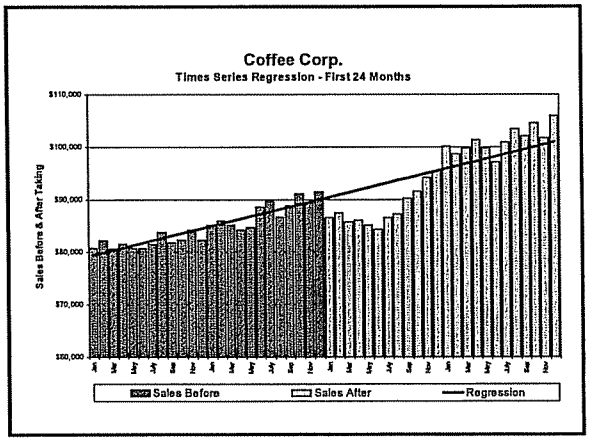
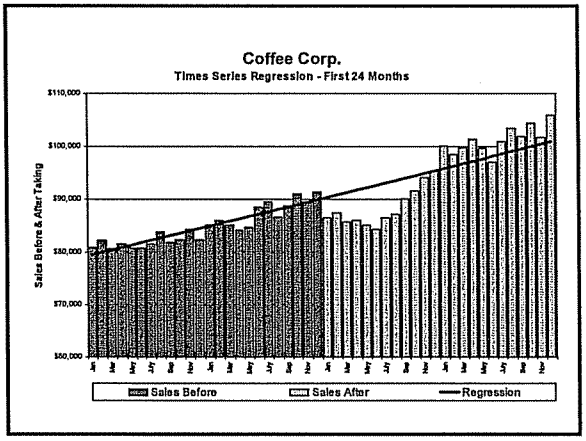


Example II – Coffee Corp.

- When the pre-expropriation sales are regressed against time, the corresponding model has $R^2 = .85$ which is promising.
- A visual examination of the regression line suggests that the model tends to over estimate the actual sales in months 5 through 17.
- More importantly, the graph clearly shows that the regression model seriously underestimates actual sales in months 37 through 48.
- There is a high probability that this model underestimates the lost sales.



Example II – Coffee Corp.

- Based on time series regression analysis, sales loss is estimated to be approximately $54,000.
- It appears that the business more than fully recovered shortly after construction ended.

Example II – Coffee Corp.

- The owner of Coffee Corp doesn't understand time series analysis. His position is that Coffee Corp sales would have been higher.
- As support, he provides sales data for his "other store", which sells the same products from premises located on the other side of town.
- "Other store" sales data is introduced into our graphical analysis.

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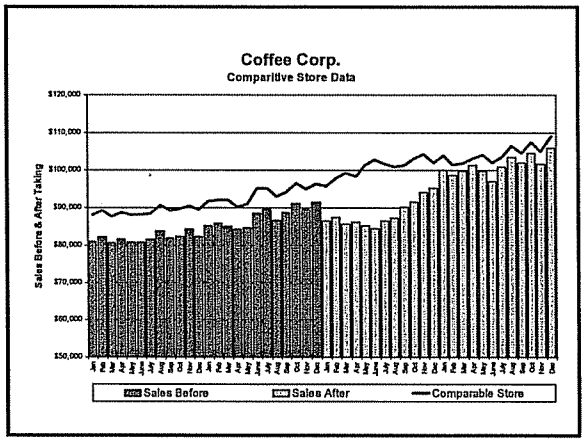

Example II – Coffee Corp.

- How well do "other store" sales predict the sales of the subject store?

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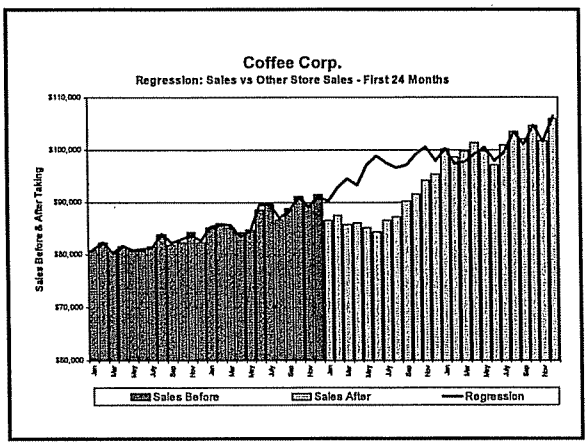

Example II – Coffee Corp.

- The linear model for sales based on the other store sales is:
  Sales = (1.225 x OtherStoreSales) - $27,085
- This model gives an extremely good fit visually.
- It explains 99% of the variation and the residuals are well behaved.
- The values predicted by the model in months 37 through 48 fit the actual sales figures very well.

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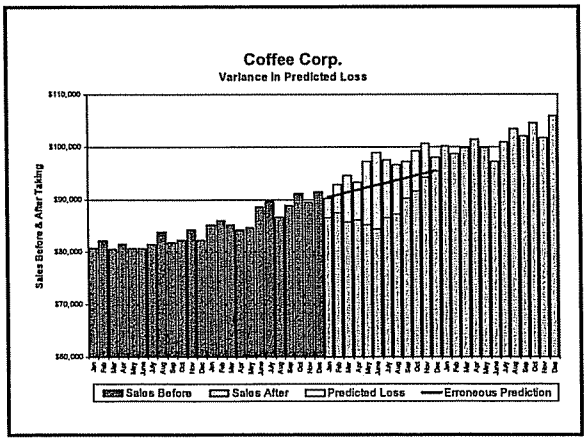

Example II – Coffee Corp.

- Based on "other store" sales, Coffee Corp's estimated loss of sales is significantly higher.
- Analysis shows that the sales loss is approximately $95,000 – which is $40,000 more than the loss predicted by time series regression.
- The analysis supports the conclusion that the adverse affection ended, and that the business fully recovered.

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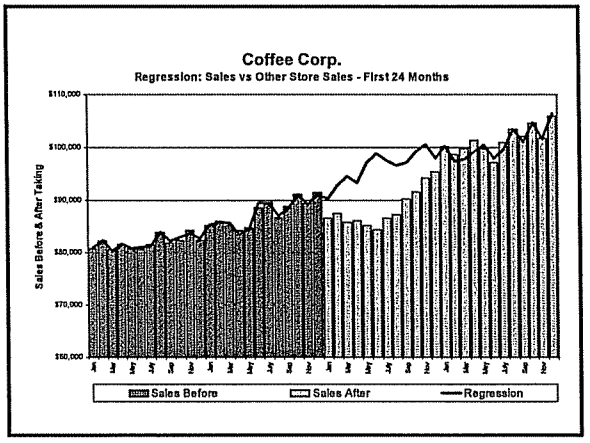

Regression Summary

- Examine the data graphically from different points of view.
- Consider various models, including possibly non-linear models.
- When testing a model, always examine the residuals.
- Be very cautious in using extrapolation.
- Combine the expertise from various fields such as business valuation, marketing and mathematics to establish the validity of the model.

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Regression Summary

- Understand the business and the facts of the matter first.
- Look at the business case. Ask some questions:
  - Why would the taking impact the business?
  - What other internal & external factors impacted the business?
- Look first to external predictors other than time. Be careful using time series regression.
- Don't blindly accept the analysis. If you use regression, make sure you have an understanding of its theory and limitations.

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