

# The Use of Regression Analysis as Evidence in Litigating Tax-Related Issues

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## Abstract

*Despite numerous published academic articles concerning the application of regression analysis as an accounting tool, its applicability as a tool in litigating tax matters has been largely ignored. This research documents the extent to which regression analysis has been used to adjudicate tax issues and points out conditions under which regression-based conclusions are considered legitimate evidence. A number of court decisions regarding federal income tax, state income tax and property taxes are reviewed to illustrate the extent to which regression analysis has been applied, its effectiveness, and implications for future adjudication of tax issues. Evidence from the reviewed court decisions indicates that regression analysis may be successfully used to uncover relevant facts, estimates or projections. However, the credibility of such evidence will depend on the observance of the underlying regression analysis assumptions and on the expert's understanding of the phenomenon under study. The use of regression analysis to conduct legal analysis (for example, predicting the outcome of litigation) is of little utility in the courtroom.*

## Introduction

In recent years, the judiciary has placed a greater level of responsibility and potential for liability on accountants with respect to financial statements and the tools used in the measurement and reporting of accounting information (*Basic Inc. v. Levinson*). In *Basic Inc.*, the U.S. Supreme Court ruled that accountants are liable to purchasers and sellers of securities who rely on financial statements even where such parties have not read or directly relied on the applicable financial statements. The Supreme Court decision legitimized the added responsibility of accountants for financial statements, which is now called the "fraud on the market" theory (Fenwick et al. 1993). The "fraud on the market" theory has implications for both tax accountants and auditors with respect to

the preparation of financial statements and tax returns and the use of certain accounting tools to substantiate accounting estimates.

Auditors and tax accountants often use regression analysis as a tool in determining appropriate sample sizes, estimating fair market values for tax and financial reporting and other related functions. In addition, accountants are often called on to substantiate estimates used for tax or financial reporting in the courts. More generally, accountants may be required to use tools such as regression analysis to reduce the incidence of factual bias in the litigation of accounting and tax matters.<sup>1</sup> The use of some accounting tools has often been criticized by both the courts and other parties

for arbitrariness or outright misapplication (Tinker 1991; Humphrey and Moizer 1990).

While prior studies (Englebrecht and Jamison 1979; Goldstein 1985; and Madeo 1979) in the tax area have used regression analysis to model the judiciary's decision of litigated tax matters, no study to date has considered the appropriateness or conditions under which tools such as regression analysis are used in litigating tax matters. The "fraud on the market" theory imposes added responsibility on tax accountants with respect to the conditions under which accounting tools such as regression analysis will be acceptable. Failure in adhering to judicial precedence regarding appropriateness and conditions under which tools such as regression analysis may apply could expose accountants to liability.

Our objective in this article is to investigate the role of regression analysis in adjudicating tax-related disagreements between various revenue authorities and taxpayers. This article also seeks to address such questions as to whether regression analysis has been used in court cases involving tax-related disputes and, if so, how effectively it has been used. The implications for the future use of regression analysis in the courtroom are also discussed. Beyond assessing the acceptability of regression analysis in the courts, this research adds to the literature by explaining the sources of factual bias in the litigation process.

#### *Prior Research Involving Regression Analysis as an Accounting Tool*

Wallace (1983) described the acceptability of regression analysis as evidence in a courtroom and its ramifications for auditors. She examined the application of regression analysis by expert witnesses in litigation of auditing matters. In addition, she assessed the evidentiary force of expert testimony that relied on regression analysis. Wallace pointed out that the use of regression analysis as a tool in litigating auditing-related issues was still unsettled. However, Wallace reported that courts have not only accepted auditing-related testimony that relied on regression models, but have also attributed substantial evidentiary force to such

testimony.

#### **The Adjudication Process**

The adjudication of tax issues is somewhat different from the adjudication of non-tax issues. One major difference is the burden of proof issue. With a few minor exceptions, the Internal Revenue Code places the burden of proof on the taxpayer (defendant).<sup>2</sup> U.S. Tax Court Rule 142(a) places the burden of proof on the taxpayer by presuming the IRS' determination of a deficiency to be correct. Similarly, for both the U.S. Court of Federal Claims and the District Court, the burden is on the taxpayer to prove that he or she is entitled to a refund.

#### *The Role of Regression Analysis*

Regression analysis is used to describe movement in a variable of central interest (the dependent variable) by examining the relative movement in one or more other variables (explanatory variables). For example, one might estimate the sales tax liability of a retailer by tracking the number of customers with sales tax exemptions, cash receipts, and the seasonality of operations. Sales taxes would be expected to increase directly with the magnitude of cash receipts, aside from the inverse effect of those customers who are exempt from sales taxes (such as other retailers). During peak seasons, the liability would be expected to increase and would decrease in the off-season.

Multiple regression analysis (so-called whenever more than one independent variable is used for modeling) will assess a linear or a curvilinear relationship with a set of independent variables concurrently. Point estimates can be formulated and related statistical measures of precision (accuracy) and confidence level (reliability) can be computed. The validity of the regression results depends on how well the underlying regression assumptions are satisfied (Belsey et al. 1980).

Advantages of Regression. The advantages of a regression modeling approach include its formality, robustness, and objectivity. The specification of a regression model requires formal analysis of the

variable of interest: its determinants, its predictable relationship to other events that occur concurrently with the event of interest, and the availability of data to measure the variables for model building. This formalization of the decision at hand, such as determining the liability for sales tax, can often enhance the understanding of variables related to sales tax. As a result, the identification of an effective means of securing a reasonable estimate for sales tax liability can be accomplished.

Robustness refers to the capability of regression analysis to be resilient to peculiarities in data sets and regression models which do not comply with the underlying assumptions of the statistical technique. Regression results have been shown to be fairly robust despite violation of the regression assumptions. That is, regression analysis has been shown to yield results that are consistent across alternative estimation approaches such as generalized least squares or ridge regression (Ramanathan 1989).

Objectivity is an inherent advantage of a quantitative tool. A generally accepted algorithm exists for the tool which is founded in statistical theory. In this regard, numerous measures of goodness of fit can be produced in support of the statistical validity of a given model. As observed in *Brown v. Gaston County*, "Elusive, purely subjective standards must give way to objectivity." *Brown* focused upon statistical measures.

**Disadvantages of Regression.** As with any quantitative tool, there are also disadvantages to using regression analysis. In a sense, these disadvantages are the "reverse" of the advantages cited. The formality of regression analysis, while advantageous, can be difficult to communicate to a layperson such as a judge or a jury member who is sometimes unfamiliar with statistics. Attorneys and judges tend to view the use of statistics, including regression analysis, "with general (and occasionally healthy) distrust" (Fisher 1980). For example, one Judge complained that class-action discrimination cases had become "contests between college professor statisticians who revel in discoursing about advanced statistical theory" (*Otero v. Mesa County School District*). This

problem, however, may largely be due to experts' tendency to use "jargonese." If intuition is emphasized rather than matrix calculations when describing regression analysis, the disadvantage of formality may be minimized.

With respect to robustness, it should be apparent that this concept is one of degree. Extreme variation from underlying assumptions is likely to generate error in estimation, despite the general robustness of regression analysis. Yet, once again, reasonably simple solutions exist to address such potential problems. Often, data transformations can be applied to create a model form that complies with the underlying assumptions of regression analysis (Belsey et al. 1980).

With respect to objectivity, if the underlying regression assumptions are satisfied, the regression results should embody little subjectivity. Although it is possible that two individuals with identical data sets and model specifications can generate the same regression conclusions, a substantial amount of subjectivity can arise in both the process of data collection and model building. For example, in tracking the effect of inflation on other phenomena of interest, should the consumer price index be used or alternatively a more specific price index that is directly related to a phenomenon being explained? Likewise, in model building, should the inflation effect be derived from the level of inflation or its rate of change? Which variable is of central interest?

This simplistic illustration of the types of issues addressed in building a regression model highlights the importance of documenting each major decision in the process and testing their sensitivity. There is little objective corroboration as to the propriety of certain decisions. The subjective steps in the process, if not founded upon common sense and prudent skepticism, can be the Achilles' heel of building a regression model.

### Research Design

The research design consists of a qualitative analysis of a sample of tax-related court decisions involving regression analysis. Utilizing

LEXIS (Mead Data Central), a search command of "regression analysis," "regression," "linear regression" and "least squares method" was conducted. Ninety-seven court decisions involving the use of regression analysis in federal state and property taxes were identified.

Based on their coverage of the various aspects of regression analysis, ten of the ninety-seven decisions were selected for in-depth review to determine (1) the context in which regression analysis was used, (2) the effectiveness of the applications as evidential matter, and (3) possible "lessons" from past experiences using regression analysis in tax-related issues.<sup>3</sup> Table 1 summarizes the court decisions used herein. The court decisions were analyzed on the courts' discussions of the three following parameters: (1) data quality, relevance, and accuracy, (2) adherence to the assumptions of regression analysis, and (3) expertise of the witnesses in regressions analysis.

### Analysis

In one of the earliest decisions involving the use of regression-based evidence, the court ruled on whether regression analysis was appropriate in evaluating the reasonableness of management's estimate of future sales in determining reasonable business needs for purposes of the accumulated earnings tax. In *Shaw-Walker Co. v. U.S.*, the taxpayer used regression analysis to forecast future sales based on prior sales, the independent variable. The court accepted *Shaw-Walker's* use of regression analysis in tandem with other evidence presented.

#### *Data Quality, Relevance and Accuracy*

Almost all of the cases examined had problems with data used in the respective regressions. The judges found the data to be inaccurate, insufficient, or irrelevant. In three of the ten decisions examined, (*Exxon Corp. v. Comm.*, *Selig v. U.S.*, *Judith Lee v. Comm.*), the relevancy of the data used in the regression was questioned by the court. In *Exxon Corp. v. Comm.*, the U.S. Court of Federal Claims rejected the expert witness' use

of regression analysis to determine the depletion value of gas. The court reasoned that the data used in the regression were not comparable to Exxon's contracts for gas.

Similarly, in *Selig v. U.S.*, an expert witness used regression analysis to determine how the purchase price of a baseball team should be allocated between depreciable and nondepreciable assets. The U.S. District Court accepted regression analysis as a viable form of evidence but found the results to be of questionable validity. The trial court considered the regression application to be flawed for a number of reasons. First, the sample of 235 players was found to contain inaccuracies. Even though the inaccuracies did not significantly distort the regression estimates, the District Court felt that the inaccuracies rendered the results unreliable. Second, several questions were raised as to whether the data used to estimate the regression were appropriate to allocate the purchase price between players' contracts and other assets.

In *Judith Lee Krause v. Comm.*, the IRS used its standard regression model for tips to estimate Judith Lee Krause's tips income as a service bartender at the Sands Hotel and Casino. The IRS' statisticians developed a series of figures representing average tip income of servers in slot machines and game areas based on various work shifts. Ms. Krause had reported \$6,473 of tip income for 1986 to her employer on Form 4070 based upon her diary. Using their standard regression model, the IRS asserted that the reported tip income should have been \$12,324.96. The IRS used a 95-percent confidence level prediction as the basis for estimating the tip income.

The U.S. Tax Court had decided earlier that the statistics developed in the Atlantic City Project were the basis of a reasonable method for reconstructing the income of cocktail servers (*Cohen v. Commissioner*, *Ross v. Commissioner*). However, in *Judith Lee v. Comm.*, the taxpayer's reporting method was found to be substantially more accurate than the IRS' method of estimation. The rationale was that the IRS' surveillance project had focused entirely upon cocktail waitresses (and not bartenders). As such, the court considered the

data to be inappropriate. In *Welch v. Helvering*, the court ruled that the taxpayer's method of re-computing income carries with it the presumption of correctness and the IRS has the burden of proving it wrong.

In some court decisions, the sample size used in the regression was also questioned. In *Paul W. and Kathryn Learner v. Comm.*, a sample size of three data points was found to be inappropriate to produce credible results. Perhaps this was the most blatant example of the misuse of regression analysis. Based on the sample size of three, the IRS's expert witness used regression to value shares of a personal service corporation for estate tax purposes. Of course, the regression results were rejected by the court. The court reasoned that three data points did not provide a sufficient sample from which to make a reliable estimate.

In assessing the credibility of regression-based evidence, the courts have also questioned the accuracy of the data. In *Selig v. U.S.* and *Texas Instruments v. U.S.*, the evidence was questioned because the data used in regression had errors. Though the errors were not of the nature to change the regression results, they were enough to cast doubt on the testimony. In the *Texas Instruments* case, the taxpayer used regression-based estimates to justify additional tax deductions for contributions to its pension plan for the years 1968 and 1969 even though the pension plan was over-funded. The company emphasized that a national, well-respected actuarial firm had provided the statistical conclusions regarding the need for additional pension contributions. A U.S. District Court found that the contributions to the plan were legitimate despite documented over-funding in prior years. This decision was upheld by the Fifth Circuit in 1977.

The judge noted that *Texas Instruments* provided evidence to support its tax position and that the evidence was based on data that were organized and analyzed according to the highest standards and methods of actuarial science. The court noted that the tools (regression analysis) used by *Texas Instruments* are the only ones available

to "mortal man" to predict the inscrutable future (p. 1334). The court further commented that the basis for funding was "honestly, conscientiously, and scientifically derived" (Ibid., p. 1335).

The courts also question regression-based evidence when the sample size used in the analysis is deemed to be inadequate. In *Benno F. Karlin v. Comm.*, the judge remarked that "to allow an estimated fuel expense based on linear regression analysis would be to allow a deduction under the *Cohan Rule* based on nothing but unguided largesse." The judge felt that "such an analysis is only an ex parte statement and does not constitute evidence" under the Tax Court's Rule 143(b).

#### *Adherence to Regression Assumptions*

The credibility of regression-based evidence critically depends on how closely the expert adheres to the assumptions of regression analysis. In *Texas Instruments v. U.S.*, the court acknowledged the necessary role of assumptions when formulating statistical projections and the problems of applying hindsight as a bench-mark in evaluating the reasonableness of statistical methods. In *George Campbell, Jr. v. U.S.*, the taxpayer's expert witness used regression analysis to value stocks of a closely-held business. The expert witness obtained the average discounts on purchases of restricted common stock and classified the discounts by institutional purchases and trading markets. A sale of unregistered stock of a reporting company to a venture capital enterprise (a rough equivalent to the term "sophisticated investor") was projected to carry a discount of 39.4 percent; for a non-reporting company, the projected average discount was 45.7 percent (Ibid., 81-5079).

The court adopted a mid-point of these two figures, 43 percent. The court noted that the 43 percent estimate masked many assumptions inherent in the use of regression analysis. Notwithstanding, the court offered the benefit of a consensus appraisal, one drawn not only from actual market experience but, more particularly, from that part of the risk spectrum that is commensurate with the facts under consideration. The court applauded the "consensus" nature of modeling ap-

proaches such as regression analysis, as well as the ability to simultaneously control for relevant factors affecting the variable of central interest, dependent variable.

However, the U.S. Tax Court took a view opposite to the view taken by the U.S. Court of Federal Claims. In *Hilton v. Comm.*, a newly constructed department store was sold to a single-purpose financing corporation and then leased back under a long-term triple net lease. The key dispute centered on the bona fides of the sale-lease back (i.e., a "substance over form" issue). The court questioned the a priori assumptions of the expert witness. In the court's view, the witness failed to establish the necessary factual link between the instant property and the regression estimates. In the analysis, the expert witness assumed that assessed land values were equivalent to actual values. The court had no difficulty with the use of regression analysis, observing that linear regression analysis is simply a process of extrapolation. Instead, the court focused on the untenable assumption that assessed value was equal to appraised value.

Other concerns of the court regarding the observance of regression assumptions include: (1) the omission of key explanatory variables and (2) the inclusion of tainted explanatory variables in the regression model. With respect to the omission of key variables in the analysis, the reason for the failure to include the variable must be provided. The inclusion of a tainted explanatory variable also may raise doubts about the regression results. The inclusion of a tainted variable was the reason for the rejection of regression based evidence in *James Stockham Valves & Fittings Co. v. Comm.* The court stressed that it may be preferable to omit tainted variables in estimating the regression but the reason(s) for omission should be clearly documented.

#### *Expertise of the Witnesses*

The courts have also questioned the knowledge of the experts in a number of the decisions examined herein. The expertise of the witness is questioned if he/she does not have a clear

understanding of the subject matter. In *Kansas City Southern Railroad Co. v. Comm.*, the court ruled for the taxpayer because the taxpayer's witness demonstrated a basic understanding of the data being analyzed and the nature of the dispute under litigation. The IRS' witness also used regression analysis to refute the taxpayer's estimated useful life of railroad grading facilities. However, the IRS' witness was discredited because the witness failed to demonstrate a basic understanding of the data being analyzed. The U.S. Tax Court leveled the following criticism at the IRS's expert witness.

*"He did not have an understanding of the property under study. Not only had he not inspected the grading of petitioner, he also was not certain what railroad grading was."*

In *Paul W. and Kathryn Learner v. Comm.*, the court reasoned that the expert witness did not have a theoretical basis to develop his/her regression estimates. The expert witness showed little appreciation for the theoretical link between the variables that were shown to be correlated under the regression technique. The court criticized the "step-wise regression" technique used as follows:

*"Respondent's expert evidently had no theory for why these ratios should be related. He claimed that he found them by analyzing key measurements to find "if any of these [key measurement] in relation to the price formed an appraisal pattern." However, comparing ratios until one finds some which appear to be related is not a recognized method of making quantitative comparisons. In particular, the analyst should be careful to make his regression studies on variables which are related to each other. In other words, he should specify his model beforehand; not simply investigate a large number of series and make his model from the series which appear to have the closest fit. Spurious "correlation" studies are frequent. For example, one might note that the decade of the 1960's was a decade of great growth in both the number of security analysts employed and in the number of auto thefts. It would be possible to come up with a fairly closely*

*fitting regression equation indicating that auto thefts rose directly in line with the number of security analysts employed. The basic fallacy, of course, is that the two series are completely unrelated. Both series are reacting to other forces--it is just a coincidence that both were a strong up-trend at the same time. In all types of analysis it is possible to be misled if one examines a large number of series. Oftentimes, the closest fit is obtained by use of factors which are not primarily related. However, the accident of close fit does not make the theory sound."*

The above quote illustrates that expert witnesses can expect their testimony to be challenged when the suitability of regression is questionable; the expert has limited understanding of the phenomenon being modeled, or when regression assumptions are violated. Indeed, in *Union Pacific Railroad Co. v. U.S.* the actual methodology used along with data used in the estimation were questioned. The judge complained that one of the state's expert witness used a regression approach that had been discredited by statistical experts.

The judge also complained that the experts' valuations differed from one another and that some of the experts had theories to defend which may have affected their choice of data and methods of valuation. The taxpayer's expert witnesses were called on to prove or disprove the state's ad valorem property tax valuation. The judge complained that the experts' conclusions differed from one another by over a billion dollars. To this end, the judge repeated George Bernard Shaw's observation that if all economists were laid end to end, they would not reach a conclusion.

## Discussion

As with other areas, regression analysis has been accepted in the courtroom as a method of reducing the incidence of factual biases. The courts have generally accepted its effectiveness but litigants must demonstrate its appropriateness and observe the underlying regression assumptions. The reviewed decisions highlighted the following points regarding the use of regression analysis in the courtroom: (1) the underlying data base must

be as "clean" as possible (i.e., without known errors); (2) the information used in model building must be relevant to the phenomenon to be predicted; (3) the expert building the model must understand the nature of the problem, the underlying data, and assumptions for issue to establish credibility when presenting evidence; (4) the sample size must be adequate to lend statistical validity to the regression model; (5) model specification should be theoretically driven; and (6) the courts do not appear to be receptive to regression-based case-analysis but appear to be quite receptive to regression-based fact-analysis.

## *The Appropriate Role of Regression*

Federal Rules of Evidence for United States Courts and Magistrates (Federal Rules of Evidence 1995) clarify the role of regression analysis in adjudicating tax disputes. Regression analysis appears to be useful for fact-analysis (reducing factual bias) for litigation support, but has little applicability for case analysis (reducing legal bias).

Federal Evidence Rule 702 provides that:

*"If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education may testify thereto in the form of an opinion or otherwise."*

The key is that the litigation support testimony must assist the "trier of facts" in understanding the evidence or in determining a fact at issue. The use of regression to predict the outcome of a litigated tax issue (reducing legal bias) may be helpful for tax planning purposes but may not carry much weight in a courtroom. Predictions of this nature fall in the province of legal analysis and have little persuasive utility in the courtroom. However, the use of regression analysis to highlight facts (reducing factual bias) relevant to the outcome of the case should be important and appropriate evidence if there are no flagrant violations of the underlying regression assumptions.

Table 1  
Regression Based Analyses Of Tax Related Cases

Court Decisions	Issues	Dependent Variables	Independent Variables	Analysis	Court Decisions
<i>Shaw-Walker Co. v. U.S.</i>	Whether regression analysis was appropriate in evaluating the reasonableness of management's estimate of future sales in determining reasonable business needs for purposes of the accumulated earnings tax.	Future sales.	Prior sales.	The court cited Treasury Regulation Section 1.537-1(b)(2) in ruling that the retrospective use of data to determine the amount of earnings needed for future business needs was inappropriate.	The court accepted the taxpayer's use of regression analysis.
<i>Texas Instruments v. U.S.</i>	Whether regression analysis was useful for determining whether a firm's contributions to employee benefit plans were reasonable in light of over-funding in prior years.	Deductible pension contribution.	Various, including rate of return of pension assets, interest rate, life expectancies and the rate of inflation.	The judge stated that the taxpayer provided evidence to support its tax position and the evidence was based on data that were organized and conducted according to the highest standards and methods of actuarial science.	The court allowed the deduction and commended the method used (regression) as having been "honestly, conscientiously and scientifically derived."
<i>George J. Campbell, Jr. v. U.S.</i>	Whether regression analysis was appropriate in determining the average discounts on purchases of restricted common stock.	Size of discounts of securities.	Various, including type of investor and trading market.	The court accepted the role of assumptions inherent in such tools as regression analysis and applauded the "consensus" nature of the modeling approach. The court also noted the ability of regression analysis to simultaneously control for other relevant factors.	The court adopted a mid-point of the regression estimates and but commented the regression-based estimates masked many assumptions. Notwithstanding, the court accepted the necessary role of assumptions that are inherent in tools such as regression analysis.
<i>Selig v. U.S.</i>	Whether regression analysis was appropriate in determining the proper allocation of the purchase price of a professional baseball team between depreciable and non-depreciable assets. Both the taxpayer and IRS used regression to substantiate their estimates.	Fair market value of players' contracts.	Various, including retention rate of players, number of players under contract.	The court accepted the role of regression analysis as a tool in litigation but considered the application of regression to be flawed in the instant case because the data contained inaccuracies and may have been altogether inappropriate for estimating the value of the players' contracts.	The court considered the regression-based estimates to be flawed for two primary reasons: (1) the data base of 235 players was found to contain inaccuracies and (2) the data base was appropriate to address the question under litigation.
<i>Kansas City Southern Railroad v. Comm.</i>	Whether regression analysis was appropriate in determining the useful life over which the cost of railroad grading facilities could be allocated.	Useful life of railroad grading facilities.	Value of new rail and value of scrap rail.	The court stated that to legitimize the use of regression analysis in the courtroom, the taxpayer or his/her expert witness must be able to demonstrate a basic understanding of the data being analyzed and the nature of the dispute.	The court ruled in favor of the taxpayer primarily because the IRS' witness could not demonstrate a basic understanding of the data being analyzed and the nature of the dispute under litigation.



<p><i>Paul W. Learner v. Comm.</i></p>	<p>Whether regression analysis was appropriate for valuing shares of a Personal Service Corporation for estate tax purposes.</p>	<p>Fair market value of shares of a Personal Service Corporation.</p>	<p>Price to book value and weighted average earnings per share.</p>	<p>The court rejected regression results because regression was applied to three data points: the court reasoned that three data points were not a sufficient sample on which to make a reliable estimate.</p>	<p>The judge stated that: "...comparing ratios until one finds some which appear to be related is not a recognized method of making quantitative comparisons... regression studies should be based on variables which are related to each other. In this case, the two series are completely unrelated."</p>
<p><i>Union Pacific Railroad Co. v. U.S.</i></p>	<p>Whether the regression-based property for purposes of the State of Utah's ad valorem property tax.</p>	<p>Value of railroad property for purposes of the State of Utah's ad valorem taxes.</p>	<p>Various, including cost indicators, income indicators, stock and debt indicators.</p>	<p>The judge commended the State of Utah for using the same methodology for all centrally assessed properties and for using both historical data along with available market data. The judge argued that some of the methods presented by the taxpayer may indeed be preferable but may not be practical because of the time and expertise required to use such valuation approaches. However, the judge complained that one of the state's expert witness used a regression analysis approach that had been discredited by statistical experts.</p>	<p>The court ruled that the State of Utah's valuation methods could not be considered to be improper and that any inaccuracies caused by the particular variables used were insignificant. Notwithstanding, the judge complained that the experts' valuations differed from one another and that some of the experts had theories to defend which may have affected their choice of data and methods of valuation.</p>
<p><i>Carol Hilton v. Comm.</i></p>	<p>Whether the expert witness' use of assessed values in lieu of actual values biased the regression results. In the instant case, a newly constructed department store was sold to a single-purpose financing corporation and then leased back under a long-term triple net lease.</p>	<p>Actual value of land for income tax purposes.</p>	<p>Assessed value of land for property purposes.</p>	<p>The witness failed to establish the necessary factual link between the instant property and the data used to estimate the regression results. The data used to estimate the regression was considered to be inappropriate by the court.</p>	<p>The court had no difficulty with the use of regression analysis, observing that linear regression analysis is simply a process of extrapolation. Instead, the court focused on the untenable assumption that assessed value was equal to appraised value.</p>
<p><i>Exxon Corp. v. Comm.</i></p>	<p>Whether regression-based determination of depletion value of gas was flawed because of inappropriate data.</p>	<p>Depletion value of gas.</p>	<p>Various, including (1) length of contract, (2) the volume of gas covered by the contract, (3) the distance of the gas from final customers, and (4) the presence or absence of a take or pay clause.</p>	<p>The judge argued that the data used to estimate the depletion value of gas was not comparable to Exxon's contracts.</p>	<p>The court took exception to the use of data from another expert witness to estimate the depletion value of gas for Exxon Corporation. The court did reject the use of inappropriate data and not regression analysis as a tool in litigation.</p>
<p><i>Judith Lee Krause v. Comm.</i></p>	<p>Whether regression-based statistical construction by the IRS of bartenders' daily tip income were more accurate than the taxpayers' daily record.</p>	<p>Tip income of bartender.</p>	<p>Tip income of cocktail waitresses based on observation of cocktail servers over a seven year period.</p>	<p>Tip income reconstruction by IRS is less reliable than taxpayer's reporting record because prior surveillance project focused on cocktail waitresses and not specifically on bartenders.</p>	<p>The taxpayer's contemporaneous diary was substantially accurate and took precedence over regression-based estimates by IRS.</p>

Fact-analysis using regression is not only appropriate (Federal Rules of Evidence, 1995), but can also be very effective at scientifically quantifying tax estimates and underlying values on which tax exposure is being disputed. The modeling of pension contributions or security valuations illustrates this point. Econometric analysis is frequently applied in antitrust, bankruptcy, breach of contract, business interruption, lost profits, and patent infringement cases, among others.

### Conclusion

Regression analysis is not a new source of evidence nor is it unique as compared to other statistical evidence in its general ability to reduce the incidence of factual biases in the courts. Indeed, probabilistic testimony in U.S. courts dates back to 1868 and is now generally accepted in civil cases, with slight inroads to criminal cases (Van Matre and Clark 1976; Randall and Frishkoss 1976). The reviewed cases indicate that statistical evidence is playing a growing role in litigation.

The weight accorded to evidence based on regression analysis depends on whether it is used to predict the outcome of the case (reducing legal bias) or alternatively to highlight the relevant facts (reducing factual bias). Much also depends on the correctness, completeness, and comprehensiveness of the regression estimates (Joseph 1975). Evidence from the reviewed cases demonstrates the critical role of the underlying data base, expertise concerning the nature of the model being applied, and observance of the underlying regression assumptions. In addition, an understanding of the phenomenon being measured or estimated will also enhance the credibility of regression-based evidence. Not only can regression analysis be applied by a litigation expert on behalf of the taxpayer, it is likely that the IRS will continue to apply regression as a basis for establishing the facts.

### Suggestions For Future Research

Future research should explore whether there are differences in the use of regression-based evidence among the three trial courts. In addition, future research should compare how regression-

based evidence is used in the U.S. District Court under a jury trial-venue as compared to the U.S. Tax Court and the U.S. Claims Court.

### Footnotes

1. Two types of biases are possible in the litigation process: a legal bias and a factual bias. A legal bias arises when a judge misapplies or misinterprets the law, while a factual bias arises when a judge disregards relevant facts or performs a suboptimal evaluation of the importance of each piece of evidence. However, the review process carried out by the court or chief judge (for example in the U.S. Tax Court) seeks to address the effects of such biases on the ultimate decision of the court. Statistical and econometric techniques have been used in the courtroom as a means of minimizing the incidence of factual bias.
2. Examples are fraud, accumulated earnings tax, and hobby losses.
3. The criteria for choosing the ten decisions evaluated herein were based on their coverage of the various aspects of regression analysis. The initial list of ninety-seven decisions was reduced to twenty-three decisions. The decisions chosen were those with extensive discussion of regression analysis. The final choice of ten decisions was guided by the depth of the coverage regarding the conditions under which regression-based evidence was accepted in the courts. Notwithstanding, the choice can be considered to be somewhat arbitrary.

### References

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4. *Benno F. Karlin v. Comm.*, TC Memo 1987-532.

5. *Brown v. Gaston County*, 457 F. 2d 1377, 1382 (CA-4, 1972).
6. *Carol Hilton v. Comm.*, 74 TC 305 (1980).
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