THE INVESTMENT LAWYER™
covering legal and regulatory issues of asset management

Vol. 9, No. 11 • November 2002 Aspen Publishers

Financial Model Risk Looms Large

by Susan M. Mangiero

Financial models are a mainstay in business law. They are used to assess investment value, quantify alleged damages, explain relationships, provide theoretical support, or debunk an opposing expert's evidence. More recently, certain events seem to be pushing financial model-related issues into the spotlight more so than in the past. Shareholders are not happy campers. Their portfolios have plummeted in value and possible reasons such as poor managerial oversight, anemic market conditions, and uncertainty about national security are unlikely to disappear quickly. Not surprisingly, lawyers are busy helping clients seek recompense. One approach is to compare stated asset values with their *true* price. With Enron, "SEC investigators are trying to determine how and when the assets whose stated value is expected to be cut were placed on the balance sheet. Regulators are looking into whether their value was artificially inflated and what executives were involved in those decisions"[1] Some mutual funds are being investigated, too. "Van Wagoner's Emerging Growth fund and MeVC, which are also both the subject of shareholder litigation, seem to have attracted SEC interest because of the recent dramatic mark-downs of their venture capital portfolios."[2] The list goes on.

Why is this important to Investment Company Act of 1940 (1940 Act) attorneys? Judging by the recent headlines shown in Figure 1, investment companies appear as vulnerable to legal action as corporations and banks. To the extent that financial models are frequently used in litigation or out-of-court settlements, it makes sense to review their basics and better understand the problems associated with misuse. One thing is clear. Bad models create problems and cannot be ignored.

Keep in mind that no individual article can capture everything there is to know about financial models and model risk, mostly because there are so many varieties, each with its own set of parameters. For example, a stock valuation model differs from a stock option valuation model in many ways. First, the former emphasizes future expected cash flows, and, in contrast, the latter emphasizes volatility of future expected cash flows, something very different in con-

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ASPEN PUBLISHERS

November/9111130065

cept and practice. Second, dissimilar mathematical processes are used to estimate the inputs for each of the two models. Third, model evaluation is a function of the instrument type and the vagaries of the market in which the security trades. Data issues and consensus about best practices are other factors.

What Is a Model?

Essentially, a model is a rule or set of rules that purports to explain a particular variable. The uniqueness of a model is based in part on a set of underlying assumptions, each of which is vulnerable to scrutiny and must reflect reality to a large extent. Consider a linear regression model that takes the general form Y = a + bX where "Y" is referred to as the dependent variable, "X" is known as the independent variable, and "a" and "b" are constants that are estimated from the data at hand.

This model could be used to explain the relationship between annual salary (*i.e.*, the dependent variable) and experience as a practicing attorney (*i.e.*, the independent variable). A fundamental assumption is that salary moves proportionately with experience. For example, if salary typically rises by approximately the same dollar amount for every additional year of experience, a linear regression makes sense. Suppose instead that salary goes up exponentially for every year of experience. Using a linear regression model incorrectly characterizes the salary-experience relationship and should be replaced with a non-linear model. Graphs of the two models, shown as Figure 2 and Figure 3, clearly indicate a difference in model outcome.

Stated another way, the true model, if linear, would predict a constant increase in wages for every additional year of experience. The rate of change is the same from point to point. In stark contrast, the non-linear model suggests that salaries rise very slowly for attorneys just starting out. Notice that either model used for this example predicts the same dollar salary for someone with a decade of experience. This highlights a critical aspect of modeling. The model alone is not the issue. Rather, the model *and* the range of values over which the model is applied are important. In any given case, both sides may be happy that a dollar amount is the same, regardless of how it came about. A model, however, which is acceptable using one input value or a narrow range of input values is nevertheless flawed and likely to be disparaged later on.

Clearly, the incorrect choice of a linear model to approximate a non-linear function is ill advised. A linear model may be appropriate, however, but still cause problems if it is incomplete. Suppose that the relationship between salary and experience is truly linear but incomplete because it ignores the relationship between education and salary. It would then be characterized as a misspecified model and open to challenge. Adding a variable that measures education would be one way to augment the original model and improve its reliability. Of course, measuring education itself may present a challenge. Are years of law

Figure 1: Some Recent Noteworthy Headlines

Headline	Publication (Date)
"Investment Adviser Defrauded Hedge Funds, SEC Suit Alleges"	*Derivatives Litigation Reporter*(January 15, 2001)
"First Eagle SoGen Sues Int'l Bank, Alleges Unfair Stock Valuation"	*Derivatives Litigation Reporter* (January 29, 2001)
"Private pitfalls of public funds"	*Financial Times* (January 30, 2002)
"Ambiguity clouds valuation methods"	*Financial Times* (February 25, 2002)
"Van Wagoner Is Criticized by Its Auditor on Practices in Valuing Certain Securities"	*The Wall Street Journal* (March 4, 2002)
"Mutual funds turn on valuations as SEC moves to steady the spin"	*Financial Times* (March 27, 2002)
"Enron Inquiry Now Focusing on Valuations"	*The New York Times* (May 13, 2002)

Figure 2: Simple Linear Model

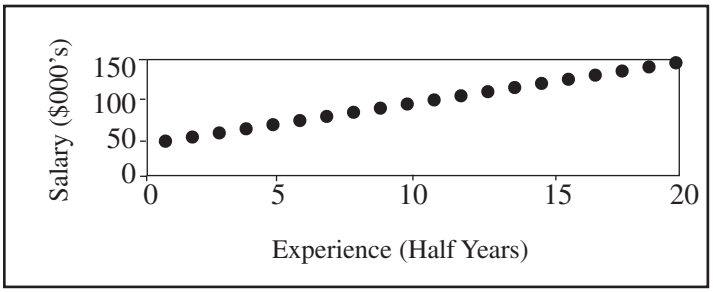
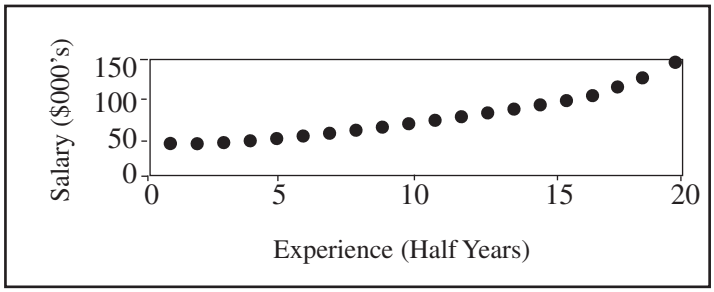


Figure 3: Not All Models Are Linear



school alone sufficient or should continuing legal education seminars be considered as well?

Model Integrity in the Courtroom

Financial experts shoulder a big responsibility, not the least of which is to ensure the integrity of any model used in providing testimony. In many situations, what constitutes good quality is decided by whether evidence comports with the guidelines set forth in the now famous 1993 US Supreme Court case, *Daubert v. Merrell Dow Pharmaceutical, Inc.*[3] Specifically, a theory or technique must have been: (1) tested or shown to be testable; (2) subjected to a review by peers; (3) evaluated to predict error rates; and (4) is generally amenable to the relevant community of experts.[4] A later case, *Kumho Tire Co. v. Carmichael*,[5] extended the *Daubert* decision to persons other than scientists.

Debunking an opponent or an opponent's evidence is not uncommon and occurred even before *Daubert* and subsequent related cases. After *Daubert*, the practice continues but is modified to reflect the state of more formalized evidentiary requirements. Some even predict a cottage industry in obtaining *Daubert* eliminations, especially as scholars evaluate documented exclusions to learn from past mistakes. A recent attempt scrutinized a broad cross-section of cases that involved accounting, valuation, or economics testimony, differentiating on the basis of whether exclusions occurred or not.[6] Applied to 1940 Act cases, model-based evidence is vulnerable to challenge for any one of a number of reasons, including but not limited to the following: (1) failing to use relevant market data; (2) ignoring or overlooking plausible alternative explanations for market conditions being what they were; (3) incorrectly applying an otherwise acceptable methodology; (4) erroneously defining model inputs; and (5) forcing assumptions despite their ill fit with reality.[7]

Beyond issues of reliability, an expert and/or the attorney must have good communication skills, especially with a jury whose members have limited knowledge of finance, math, or statistics. At the very least, someone has to provide a plainspoken explanation about a model's purpose, critical underlying assumptions, and when alternatives could be considered. That first requires understanding what a model represents and its possible flaws.

Model Risk Defined

No single universally accepted definition of model risk exists although most would agree that it occurs whenever the suitability of a model is in question. Is any model infallible? No, there is no perfect financial model and there never will be. Economic and regulatory conditions change. New information is learned. Computational techniques may improve. Data never before available is now easy to obtain.[8] In addition, sometimes a model may be rendered useless because of an unforeseen calamitous event. The tragic launch of the space shuttle Challenger and the vaporization of Long Term Capital's fortunes are two prominent examples.[9] In their aftermath, much time and energy were expended in understanding where and why the relevant model broke down. All of these factors force model builders and users alike to readjust accordingly.

Although it is hard to precisely define model risk, some attempts have been made to classify model risk by type. Dr. Emanuel Derman, cites types of model risk to include the following: (1) "incorrect model"; (2) "correct model, incorrect solution"; (3) "correct model, inappropriate use"; (4) "badly approximated solution"; (5) "software and hardware bugs"; and (6) "unstable data."[10] This list cuts a broad swath to be sure, especially when *Daubert* standards are factored in.

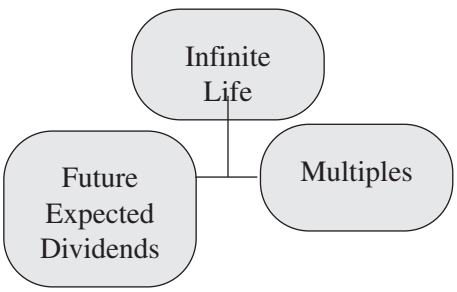
Risk is not equal across models and depends on the type of model. More complex approximations are typically considered more vulnerable than their simpler brethren. Unfortunately, few financial instruments are straightforward and ignorance is definitely not bliss. The best bet is to select knowledgeable financial experts who are capable of wearing several hats. They must be able to evaluate a model for its weaknesses and strengths. At the same time and as stated previously, the ability to communicate technical concepts in a straightforward fashion is paramount. Part of this process entails breaking down a model into constituent parts that a non-financial person can understand. This is especially true for security models that have expected payoffs that could change if a specified event occurs. For example, future anticipated cash flows for a mortgage-backed security are directly affected by factors that influence whether borrowers refinance. This might occur if interest rates fall by an amount large enough to make refinancing attractive.

Taxonomy of Financial Models

Just as the field of law is broken down into specialty areas, so too is finance. Each branch has its own family of models and the models can sometimes differ quite dramatically from one area to the next. A corporate finance model that seeks to determine optimal capital structure is quite different than a model used to value a forward contract on a good credit quality rated corporate bond. Even within a particular branch of finance, models can and do differ. Consider the aforementioned corporate bond. One model might project future expected interest and principal payments and find today's value assuming a constant yield to maturity. A second model might use the same cash flows but discount them back to the present using a different rate, adjusted for risk of time before the investor should receive cash flows. A third model might incorporate different interest rate scenarios to determine how future expected cash flows could vary if prepayment is an issue. The list goes on. The challenge of evaluating the best model and the model risk associated with use of a poor alternative is a reality that no lawyer can ignore.

Think about common stock valuation models (shown in Figure 4). The dividend discount and multiples-based models are two frequently used approaches, each one assuming an infinite economic

Figure 4: Frequently Used Common Stock Valuation Models



life (see Figure 5 and Figure 6). The former assumes that future expected cash dividend payments drive today's value of a stock. The latter takes into account financial ratios as a way to back into an imputed price an investor should be willing to pay. Both models are regularly used in practice. The issue is whether they are ever incorrectly applied. A model based on dividend payments is useless if applied to a company that pays no, few, or irregular cash dividends. Worth mentioning is the fact that many publicly traded software companies have never paid cash dividends to shareholders (although they sometimes pay stock dividends). Furthermore, dividend payout rates change over time and not always in proportion to past payments. When this occurs, a constant growth rate model no longer makes sense. In recent years, dividend-paying companies have reduced dividend payments in favor of buying back shares or otherwise reinvesting monies.[11]

Dividend estimates are not the only variable open to question. What happens when the model inputs themselves come from models? A critical input to the dividend discount model is the rate used to find the present value of future expected cash flows. This variable is frequently derived using a linear equation known as the Security Market Line and depends on having a reliable way to evaluate the sensitivity of a stock to changes in a market index. Complicating things, the market risk measure known as beta can vary a great deal depending on the nature of the data and the precise structure of the beta estimation model.[12]

Figure 7 illustrates the concept of nested models. Primary inputs to the dividend discount model are themselves derived. This means that any error made in estimating inputs will have a lingering and deleterious effect on results from a final model. An inaccurate beta results in an imprecise discount rate and this

Figure 5: Variations of the Dividend Discount Model

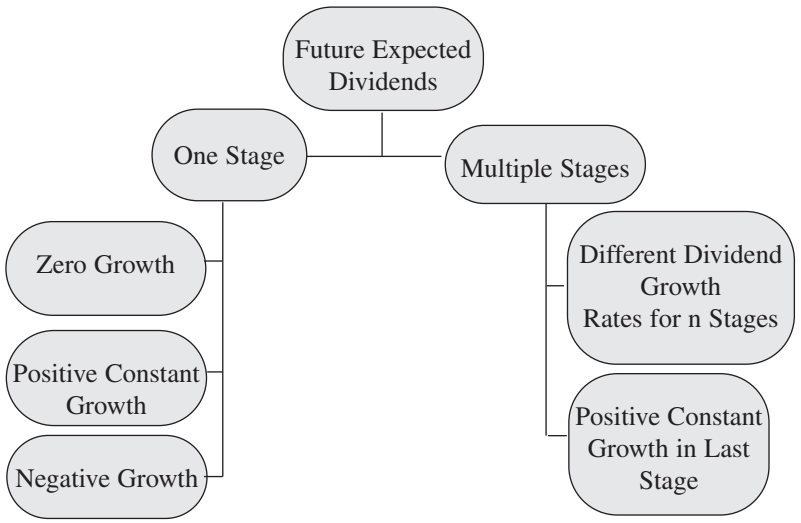


Figure 6: Variations of the Multiples Model

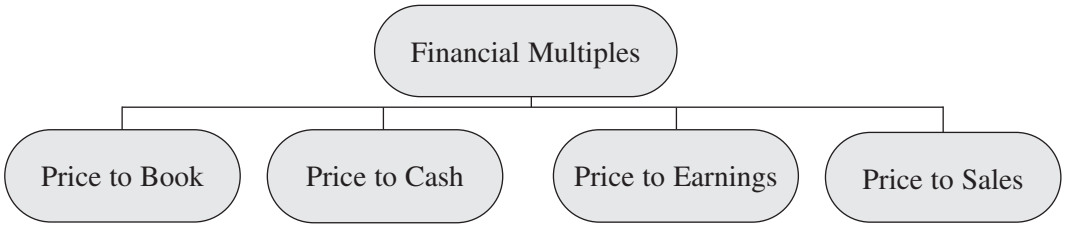
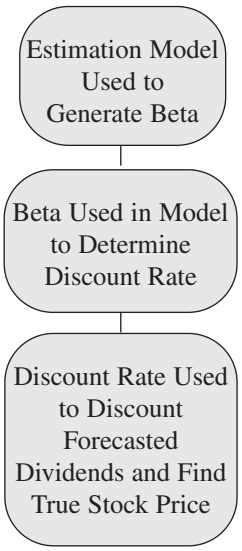


Figure 7: Example of Nested Models



leads to an incorrect stock valuation when the dividend discount approach is employed. The problem occurs when model risk is overlooked for any of the component models in a chain of interrelated algorithms. The worst-case scenario is to ignore model risk altogether, giving the opponent the advantage and possibly losing valuable clients at the same time.

Summary

Model risk is a fact of life. It is a central part of many legal proceedings and is likely to increase in importance, especially given the flurry of litigations alleging incorrect asset valuations. Oddly, little has been written about model risk for attorneys so those who familiarize themselves with the concept have a big advantage over their competitors.[13] Knowledge is a powerful arsenal, especially when the issues at hand are complicated and misunderstood by others.

NOTES

1. David Barboza, "Enron Inquiry Now Focusing on Valuations," *The New York Times*, May 13, 2002.

2. Robert Clow, "Mutual Funds Turn on Valuations as SEC Moves to Steady the Spin," *The Financial Times*, March 27, 2002.

3. "*Daubert*" is a shorthand term, used to refer to the evidentiary guidelines established by the US Supreme Court in Daubert v. Merrell Dow Pharmaceuticals, Inc. 509 U.S. 579, 113 S. Ct. 2786 (1993). A later case, *Kumho Tire Co. v. Carmichael* 119 S. Ct. 1167, 1999, extended the *Daubert* decision to persons other than scientists.

4. "*Daubert* and the Law and Science of Expert Testimony in Business Litigation: Lose on Liability and Still 'Win' the Case?," *www.daubertexpert.com/winningcases.htm.*

5. *Kumho Tire Co. v. Carmichael,* 119 S. Ct. 1167 (Sup. Ct., 1999) *www.westbuslaw.com/cases/daubert.html.*

6. Alan Ratliff and Sofia Adrogue, "Kicking the Tires after *Kumho*: The Bottom Line on Admitting Financial Expert Testimony," *Houston Law Review*, Volume 37, Number 2, Summer 2000.

7. Refer to "*Daubert*'s Impact on Antitrust: Preparing for *Daubert* Challenges in Antitrust Cases," Robert G. Badal and Edward J. Slizewski, December 2001, *www.hewm.com/use/articleDetails.asp?articleID=500*.

8. Data for new financial instruments is often not available until a sufficient trading history can be compiled.

9. *See* "LTCM Speaks," Joe Kolman, *Derivatives Strategy*, April 1999. *See also* "Challenger: Fine-Tuning the Odds Until Something Breaks," William H. Starbuck and Frances J. Milliken, *Journal of Management Studies*, 1988, 25, 319–340.

10. Emanuel Derman, "Model Risk," *Goldman Sachs: Quantitative Strategies Research Notes*, April 1996.

11. *See* "Dividend Payments Still Stuck in the Doldrums," Alison Beard, *The Financial Times*, April 3, 2002.

12. A beta estimate can vary for many reasons. Choice of index is a big factor. For example, estimating the beta for a company with a small market capitalization can be done using either an index of companies with large market capitalization or a broader based index that includes medium-size and small companies, as well. The difference in resulting beta estimates are often very far apart.

13. *See* Susan M. Mangiero, "Model Risk Is Serious Business," *AFP Exchange*, September/October 2002.

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