The Matrixx of Materiality and Statistical Significance in Securities Fraud Cases

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Introduction

Zicam nasal spray causes loss of smell. That was the claim, at least, by several doctors and plaintiffs between 1999 and 2004. The question was whether it was true. On the one hand, there had been some 12 to 23 adverse event reports (AERs) of users losing their sense of smell after using the popular cold remedy. On the other hand, the reports were just stories—possibly true, possibly not—and the number of reports was miniscule relative to the millions of units sold. The number was so small, in fact, that the drug’s manufacturer, Matrixx Initiatives, Inc. ("Matrixx"), described it as not statistically significant. In other words, there was no evidence that would be accepted at common statistical standards that the spray actually caused users to lose their sense of smell. The same number of people using a placebo might have reported losing their sense of smell, too. So Matrixx stayed quiet.

That changed on February 6, 2004, when Good Morning America aired a segment alleging that Zicam causes users to lose their sense of smell. Matrixx’s stock price plummeted, and a federal securities class action lawsuit quickly followed. The suit, brought under § 10(b) of the Securities and Exchange Act of 1934 and Rule 10b-5, alleged that the company should have disclosed the adverse event reports. But should it have? That is the question currently pending before the United States Supreme Court: whether undisclosed information can be material even when it is not statistically significant.

In this paper, we discuss the importance of this issue and highlight the salient factors that one should consider when using statistical significance in securities fraud cases. Our goal is to assist those facing this and similar issues in understanding exactly what statistical significance is, what role it should play in the law, and what is at stake. In short, this issue is important because it relates to how much information a company must disclose. Disclosure is costly, both for companies to produce and for investors to assimilate, yet it is also essential to the fair and efficient operation of the capital markets. In light of this delicate balance, statistical significance
offers courts and companies something vital: an objective rule that promotes certainty. Statistical significance is an objectively verifiable way of using measurements of the observed relationship between two or more phenomena to estimate the potential chance of falsely claiming that there is a true underlying relationship present when in fact there is not. If used properly, this can be a powerful and useful tool.

We stress, however, that statistical significance plays a very specific role in the law depending on its context. Namely, for materiality, statistical significance typically speaks to how unusual an underlying event is, but not (or at least not directly) to its magnitude. In other words, statistical significance can be a direct measure of the validity of a result. A related concept, practical significance, deals with the magnitude and importance of the effect, assuming that the effect is valid or real. Materiality ultimately depends on both types of significance, taken together. We note that medical and other events with low statistical significance may still have practical, qualitative significance, and hence might be material to a rational investor. The AERs may, in fact, convey valuable information to rational investors, despite the lack of statistical significance. Furthermore, we note that it is a rational investor who is able to make these distinctions ex ante, or before observing a change in stock price. For movements in stock prices are, in fact, measures of the value of the information itself to investors, meaning that statistical significance of stock price movements is more directly tied to, if not treated the same as, materiality. If our underlying assumption is instead that investors or consumers are irrational, then our legal prescription may or may not change in light of how much paternalism one deems appropriate.

Finally, the Supreme Court’s decision may have far-reaching effects in securities litigation. It is likely that either plaintiffs or defendants will take the Supreme Court’s decision in Matrixx and attempt to extend its holding on the statistical significance of the number of AERs to the measurement of the statistical significance of price movements. For example, if the Court rules that one need not show that the number of AERs is statistically significant to be material, plaintiffs may argue that it is not necessary for them to show that a security’s price movement is statistically significant to be material. Conversely, if the Court holds that the number of AERs must be statistically significant to be material, defendants are likely to argue that security price movements must similarly be statistically significant to show materiality. This is not to say that either position is correct, but merely that litigants are likely to argue one or the other depending on what the Supreme Court holds in Matrixx.

**Statistical Significance: Definition and Discussion**

A discussion of how materiality and statistical significance are connected in the law requires an understanding of both concepts. In this section, we discuss the concept of statistical significance, which is a well-defined statistical term. In the next section, we see how that concept interacts with various definitions of materiality given in the law.

**What is statistical significance?**

One recent decision that provides a helpful discussion of statistical significance and its application to securities fraud cases is In re American International Group, Inc. Securities Litigation Group, Inc., 2010 WL 646720, at *3 (S.D.N.Y. Feb. 22, 2010) ("AIG"), which relied heavily on the Reference Guide on Statistics, a part of the Reference Manual on Scientific Evidence, Second Edition published by the Federal Judicial Center ("Reference Guide on Statistics"). In AIG, Judge Batts both provided the relevant definition of statistical significance and showed how one could apply it properly in a securities litigation case.
To begin, the AIG Court noted that the “statistical significance of a measured effect, in this case a [stock or bond] price decrease attributable to disclosures, is determined by ‘comparing a p-value to a pre-established value, the significance level.’” *Id.* (quoting *Reference Guide on Statistics*). The AIG Court further noted that a p-value “is the ‘probability of getting data as extreme as, or more extreme than, the actual data, given that the null hypothesis is true.’” *Id.* (quoting *Reference Guide on Statistics*). A high p-value means the data, or data more extreme, are more expected or likely, given that the null hypothesis is true. A low p-value means the data, or data more extreme, are less likely, given that the null hypothesis is true. Once the p-value drops below the pre-established value, the analyst rejects the null hypothesis and considers the data statistically significant.

Although this definition should feel intuitive to an expert in statistics, it will often sound confusing to others. To understand the definition, consider the case of flipping a coin as a test of whether the coin is unbiased (i.e., whether it should come up heads 50 percent of the time and tails 50 percent of the time). Suppose that we flip the coin twice. If we used a fair coin, the probability of getting both flips in the same direction (HH or TT, where H and T represent heads and tails, respectively) is represented by two out of the four possible outcomes, or 50 percent. The probability of getting one flip in one direction and one in the other is 50 percent (HT or TH).

Suppose that we tested this coin to see if it was biased. Our null hypothesis is that the coin is unbiased, meaning that half the flips should be heads and half should be tails. With two flips, a result of HH or TT would have a p-value, also known as the observed level of statistical significance, of 50 percent, because that is the likelihood of getting results as extreme or more extreme than 100 percent in one direction if the coin was fair (i.e., if the null hypothesis that the coin is unbiased is true). Any result with one flip of one type and one of the other would have a p-value of 100 percent, consisting of the 50 percent for an outcome as extreme of two flips in the opposite directions plus the 50 percent for the more extreme outcome of both flips in the same direction. While a p-value of 100 percent, or 1.0, may sound strange, its interpretation is in fact quite intuitive: if the coin is fair, we will get results at least as extreme (i.e., as far from 50/50) as having one flip in each direction. Having one flip in each direction is exactly 50/50, and therefore provides no evidence against the hypothesis that the coin is unbiased.

As noted above, the p-value is the observed level of statistical significance. It is in fact defined by the *Reference Guide on Statistics* (p. 168, emphasis added) as “the output of a statistical test.” This is consistent with much of current practice, in which the p-value is reported as the primary outcome of a statistical analysis. To determine whether a result is statistically significant, one compares this result to a pre-determined level. *The Reference Guide on Statistics* notes (p. 124, concluding footnote omitted) that “[t]he .05 level is the most common in social science, and an analyst who speaks of ‘significant’ results without specifying the threshold probably is using this figure.” The Court in AIG similarly found that while the academic literature on event studies may report results at a level weaker than the 5 percent, or 0.05, level of statistical significance, that such reporting “does not demonstrate, however, that it is consistent with standard methodology in financial economics, or in conducting event studies specifically, to draw conclusions at the 10% level.” The Court then rejected plaintiffs’ claim for a finding of loss causation based on event studies that purported to have found results statistically significant at the 10 percent level but not at the 5 percent level.
Statistical Significance is Not the Probability of the Null Hypothesis Being False

One other point correctly noted by the Court in AIG was that a “finding of a price decrease attributable to the disclosures at the 10% level of statistical significance is not the same as a finding that there is a 90% chance that there was a price decrease attributable to the disclosures.” In doing so, the AIG Court corrected plaintiffs’ expert in that case, who made the incorrect statement that there was a 90 percent chance that the observed price movements were due to the events he examined.

While the AIG Court derived its explanation by citing to and explaining the same reasoning given in the Reference Guide on Statistics, the example above of flipping a coin three times provides a complementary explanation. We previously noted that the p-value for the coin coming up the same way, heads or tails, in all three flips was 25 percent. That does not mean that there is a 75 percent chance that the coin is biased (i.e., that the results were due to a failure of the null hypothesis of the coin being fair) and only a 25 percent chance that the results were due to chance. Furthermore, when the coin comes up twice one way and one time the other, the p-value is 1.0. This certainly does not mean that there is a 0 percent chance that the coin is biased. In fact, the result is perfectly consistent with the coin being biased to come up one way two-thirds of the time and the other way one-third of the time. As noted by the AIG Court, “the fact that a financial model finds a statistically significant price decrease at the 5% level on a particular day, attributable to the disclosure of previously omitted or misstated information, cannot be interpreted as meaning that there is a 95% chance that the measured price decrease attributable to the disclosures is real [i.e., that the null hypothesis that there was not material event is false].” Footnote 42 of the Reference Guide on Statistics notes that unfortunately not all courts have noted this distinction carefully (with the most common type of error known as the Prosecutor’s Fallacy, as noted in footnote 167 of the Reference Guide on Statistics).

Multiple Tests and Statistical Significance

One of the other relevant issues with statistical significance is what happens with multiple testing. As noted on page 127 of the Reference Guide on Statistics, “Repeated testing complicates the interpretation of significance levels.” To see why, consider flipping a coin six times. The probability that all the flips will come out the same way is one in 32, or about 3 percent. (The probability that the second flip will match the first is one-half; the probability of that being true and the third flip matching the first two is one-quarter, and so forth through the sixth flip.) This result would be considered statistically significant at the standard 5 percent level because it is unlikely to occur 5 percent of the time if the coin was unbiased.

Now consider what would happen if one were to flip 100 coins, six times each. On average, about three would come up with the same result on all six flips. It may be tempting to state that those three coins showed a statistically significant measure of bias. But this result is not at all unexpected. The issue here is known as “multiple comparisons,” which the Reference Guide on Statistics defines as follows: “Making several statistical tests on the same data set. Multiple comparisons complicate the interpretation of a p-value. For example, if 20 divisions of a company are examined, and one division is found to have a disparity ‘significant’ at the 0.05 level, the result is not surprising; indeed, it should be expected under the null hypothesis.”
The same problem will often be encountered in securities litigation. Often, price movements on multiple dates are examined, making it easier to find a “significant” disparity between the predicted and actual price movement. And, if the expert does not disclose all of the tests performed, we may only know about the results claimed to be statistically significant, partially or fully obscuring the multiple tests performed. While it is beyond the scope of this paper to discuss how to adjust for such issues, they are relevant in many securities litigation cases.

Practical and Statistical Significance
One important issue in considering how statistical significance relates to materiality is the difference between practical and statistical significance. In a non-technical sense, statistical significance examines some feature of the data and asks the question, “How unusual?” while practical significance looks at that feature and asks, “How large?”

For example, one could imagine a diet pill that caused people to lose one ounce of weight over the course of a month. Suppose that by carefully controlling all the food intake and exercise of the group receiving the diet pill and the one receiving a placebo, we reduce the variation of weight change in each group and show that there was a difference between the two groups, of one ounce of weight loss per month, that is of a magnitude that is highly unlikely to be caused by chance alone (the definition of statistical significance). The result would then be statistically significant. But a weight loss of one ounce per month, less than a pound per year, would generally not be considered practically significant, meaning that it is not, in some sense, important.

Materiality depends on a combination of statistical and practical significance. Just as a small, statistically significant amount of weight loss may not be material, so too might a finding of a large amount of weight loss in a single person: while the amount may be large (practically significant), it might be a weight change that could easily happen by chance alone (statistically insignificant).

Statistical Significance Levels and the Burden of Proof
As noted in the Reference Guide on Epidemiology, “A common error made by lawyers, judges, and academics is to equate the level of alpha [the level of statistical significance] with the legal burden of proof. Thus, one will often see a statement that using an alpha of .05 for statistical significance imposes a burden of proof on the plaintiff far higher than the civil burden of a preponderance of the evidence (i.e., greater than 50%). … This claim is incorrect, although the reasons are a bit complex and a full explanation would require more space and detail than is feasible here.”

While a technical explanation of the reasoning is indeed complex, we can use our example of coin flips to obtain an intuitive feel for why the level of statistical significance does not equate with the burden of proof. Consider flipping a coin twice to see if it is biased. Half of the time the two results will be the same (HH or TT), and half of the time they will correspond to the 50/50 division of a fair coin (HT or TH). Suppose that the result was either HH or TT. The level of statistical significance, or alpha, is 50 percent, because we would get results that extreme, or more extreme, 50 percent of the time if the coin was unbiased. Unless one argues that one is just at the burden of proving by a preponderance of the evidence that a coin is biased if it comes up the same way on two flips, especially, as in the example above, with no reference to any background knowledge on how common biased coins are, then the level of statistical significance should not be equated with the burden of proof in a legal matter.
A Word on Terminology

One may often hear the statement that one has “failed to reject the null hypothesis.” Why, one may ask, do statisticians not simply say that they have accepted the null hypothesis?

To see why this is the proper usage, consider the null hypothesis that a coin is unbiased. Suppose that one flipped the coin 100 times and it came up heads 50 times and tails 50 times. That is as unbiased a result as one could get. And it should be fairly clear that the coin could not be so biased as to give heads 90 percent of the time that it is flipped. But, it certainly could give heads 51 percent of the time on average, with the 50/50 actual result being just one off from the prediction for such a coin. Moreover, the coin could be biased to yield heads 50.0001 percent of the time. Because the null hypothesis of no effect is so narrow, there will almost always be some alternative possibility that is consistent with the data. Hence, statisticians generally speak not of accepting the null hypothesis, but instead of whether the evidence is so strong as to allow them to reject the null hypothesis.

Also, the evidence against the null hypothesis may be weak. Consider one more time the example of the coin that is flipped three times and comes up heads twice and tails once. The evidence is insufficient to allow us to reject the null hypothesis that the coin is unbiased—the evidence was in fact as close to an unbiased result as one could have gotten. But it would be incorrect to state that the evidence leads us to accept the null hypothesis that the coin is unbiased. Instead, what one can say is that the evidence is not strong enough to allow us to find that the coin is biased; that is, we fail to reject the null hypothesis that the coin is unbiased.

Finally, lawyers should in fact be quite comfortable with this form of expression. In a criminal case, the defendant is innocent until proven guilty. The null hypothesis is that the defendant is innocent. When there is sufficient contrary evidence, the jury can reject the null hypothesis of innocence and find the defendant guilty. But, when the evidence against the null hypothesis is weak, juries do not find the defendant innocent; instead, they choose not to reject the null hypothesis, finding that the evidence does not support a verdict of guilt.

Materiality

This section discusses the law’s various approaches to materiality in federal securities cases and the role of statistical significance in each.

The “total mix” of information

In *TSC Industries Inc. v. Northway, Inc.*, the Supreme Court held that an omitted fact is material if there is a “substantial likelihood” that a “reasonable investor” would have considered its disclosure to have significantly altered the “total mix” of information made available. The Court has expressly adopted this standard for § 10(b) and Rule 10b-5 causes of action.

Although statistical significance can be a factor to consider under this standard, it clearly does not encompass the “total mix” of information available to market participants. To the extent that one is examining the statistical significance of non-financial information, there is no guarantee that the information considered would be material even if undeniably statistically significant. For example, if most patients developed a minor cold from a product that makes up less than 1 percent of a pharmaceutical company’s revenues, the medical effects might be shown to a high degree of statistical significance, but the financial implications may be trivial and, therefore, immaterial.
Conversely, some information might be highly material yet not statistically significant. For example, information of a highly qualitative rather than quantitative nature, such as news that a company’s CEO is in poor health, often does not lend itself to statistical analysis. Nevertheless, investors might consider such information relevant to their investing decisions.

Finally, note three important aspects of this standard that will become prevailing themes when considering the materiality standard. First, the “total mix” of information is a fact-intensive, totality-of-the-circumstances test that promotes flexibility but inhibits certainty. Second, the standard looks to rational, not irrational, investors. Third, in formulating this test, the Court was careful not to set too low a standard so as not to “bury the shareholders in an avalanche of trivial information.” Implicit in the Court’s concern is the assumption that information is costly. Whether these decisions and assumptions are valid in all circumstances is less than clear. In the case of AERs, they are already collected by the FDA. Moreover, it may not be costly to post information already collected on the web. True costs for companies are more likely to be found in situations in which the actual collection of the data is difficult, though costs for investors could still increase as the amount of information provided increases.

**Probability x Magnitude**

Although the Court’s “total mix” standard in *TSC Industries* is facially clear, its breadth and fact-intensive nature have engendered several alternative or supplemental standards. In *Basic Inc. v. Levinson*, the Court expressly adopted the *TSC* standard in the § 10(b) and Rule 10b-5 context, but it noted that the standard “admits straightforward application” only where the impact of information is “certain and clear.” Where events are “contingent or speculative in nature,” the Court held that materiality depends instead on “the indicated probability that the event will occur and the anticipated magnitude of the event.”

The facts of *Basic* involved merger negotiations that, at the time, may or may not have culminated in an ultimate merger. The Court’s materiality formula of probability x magnitude, however, logically extends to any corporate event. Few events have a probability of 100 percent. Instead, many events are “contingent or speculative in nature” if one considers that defendants may not know the ultimate truth of a matter. In Matrixx’s case, for example, the perceived probability that Zicam causes loss of smell is unlikely to be 0 or 100 percent, but instead somewhere in between. Consequently, early on, Matrixx presumably did not (and may still not) know whether Zicam causes a loss of smell, and could only have truthfully disclosed information that would have allowed the market to guess or estimate whether Zicam had such an effect. The same will be true in many product liability contexts.

Recall from our earlier discussion, however, that statistical significance relates to how unusual a result is, and particularly the probability that results as extreme or more extreme than those actually observed would be found if the null hypothesis is true. Thus, statistical significance has some relationship to the idea of probability in *Basic*, though these are measurements of different forms of probability. Practical significance, on the other hand, goes to magnitude. In other words, statistical significance will speak to the probability factor of *Basic*’s formula, but not the magnitude.
For example, say that there is a statistically significant relation between Zicam usage and sneezing mildly. Due to the statistically significant medical finding, the probability that the market would accept that Zicam causes mild sneezing may be very high, but the magnitude of the effect on Matrinx’s stock price may be so small that the product of the two is immaterial. Conversely, say there is some probability that Zicam usage causes instant death, but the probability is so low that the relationship is not statistically significant. In this case, it is less clear that Matrinx would be found liable from a product liability standpoint; however, if it were found liable, the financial consequences to the company could be enormous. From the point of view of investors in Matrinx’s stock, disclosure of this information would reveal a small but nonzero probability of a large financial magnitude, which might be material to rational investors. In addition, of course, there are other factors that investors would consider, such as the probabilities that consumer demand would decline or that Matrinx would voluntarily withdraw Zicam, with the resulting effects on Matrinx’s future profits and hence its stock price. A key point to note here is that there are different probabilities and magnitudes involved: the probability of a medical effect, the “magnitude” of that medical effect, the probability of changes in consumer and company behavior and the financial effects of each on the company, and the ultimate effect of investors’ views of these prior probabilities and magnitudes on their valuation of the company’s stock.

For the data other than securities’ prices, all that statistical significance can tell us is whether the data are unusual, meaning unusually different from some hypothesized level. For example, if there are the same number of reports of death and sneezing, and if the background rates of the two were the same, the measurements of statistical significance for these two medical outcomes would be identical. The importance of the two types of adverse reactions, however, is very different both medically and with respect to the valuation of the company’s stock. With stock price data, courts that have used statistical significance as a proxy for materiality may be making two sorts of assumptions. The first is that if a stock price movement is not statistically significant, it is immaterial. This can be justified by recognizing that if a stock price movement is not statistically significant (originally meaning that it signified nothing), it would be impossible for plaintiffs to prove that there was any loss causation. It does not follow, however, that all statistically significant stock price movements are also material in their magnitude, though it may be the case that for most stocks with reasonable variation in their returns, a daily price movement that is statistically significant will also be practically significant. In fact, in accepting or rejecting stock price movements as evidence of a causal factor based solely on statistical significance, courts can be said to have implicitly adopted these views.

Not only does statistical significance only speak to probability, but we are also missing something else: the other side of Basic’s equation. Once we have the probability and magnitude of an event, it is unclear what we compare it to and at what threshold it becomes material. For example, one could compare probability x magnitude to revenues, and the threshold could be 5 percent. But an equally plausible comparison could be 10 percent of earnings. Thus, although Basic’s formula seems well-suited for the probabilistic nature of financial events, we need more guidance on how to use it for materiality determinations.
Finally, with our three themes, note that first, *Basic* evinces some attempt to add certainty to the materiality inquiry through the use of a formula. At the same time, however, the Court admonishes that although a “bright-line rule indeed is easier to follow . . . [a]ny approach that designates a single fact or occurrence as always determinative of an inherently fact-specific finding such as materiality must necessarily be overinclusive or underinclusive.”12 Second, the Court reaffirms its endorsement of the rational investor in stating that the “role of the materiality requirement is not to ‘attribute to investors a child-like simplicity.’”13 Third, it reiterates TSC’s concern not to flood the market with “an overabundance of information” of potentially “dubious significance.”14

**Rule of thumb**

The desire for certainty has led some lower courts to adopt an even simpler standard of materiality: the rule of thumb. In *Ganino v. Citizens Utilities Co.*, for instance, the Second Circuit reversed the district court’s holding that an event is material if it “might affect a company’s earnings, positively or negatively, by 3% to 10%.”15

Perhaps surprisingly, a rule of thumb can be tied, albeit loosely, to statistical significance in that both examine deviations from an expected value. The difference is that rules of thumb are often given to be the same for all firms and for all types of financial (and potentially non-financial) measures. In contrast, the boundaries for what measurements are statistically significant are meant to be determined based on the particular data being measured, so that it may take a 3 percent change in quarterly sales for one company to be statistically significant at the standard 5 percent level, for another company, only quarterly changes of 8 percent would qualify.

Although the Second Circuit in *Ganino* criticized the district court’s holding as contrary to the Supreme Court’s mandates in TSC and *Basic*, the district court had reasoned that most auditors and their corporate clients defined materiality in this way.16 Thus, the decision highlights how companies develop their own standards of materiality in order to enhance certainty for their daily operations, despite the Supreme Court’s different standards. By analogy, even if the Supreme Court holds in *Matrixx* that a plaintiff can show materiality in the absence of statistical significance, companies may continue to use it as a proxy for materiality for their own purposes.

**Market reaction**

The desire for certainty in materiality determinations leads us finally to a metric with perhaps the most promise but also the greatest pitfalls: the market. Logically, if materiality is what a rational investor considers pertinent, then there is no better measure than the market price, which in an efficient market should impound all material information based on certain key assumptions.17 If, therefore, rational investors consider certain information to be material, then the market price should react accordingly following the information’s public disclosure. The market is a particularly attractive measure because it takes the materiality inquiry out of the hands of a single judge, or a handful of jurors, who ask themselves whether a hypothetical investor would consider information pertinent, and places it into the hands of millions of actual investors who have considered whether the information is pertinent in making actual investment decisions.
The Third Circuit has been the greatest advocate of the market view of materiality. In *Oran v. Stafford*, the Third Circuit faced facts remarkably similar to those in *Matrixx*. There, a pharmaceutical company received numerous pieces of data, including AERs, indicating that its diet drug Fen-Phen may cause valvular heart disease. The information went public slowly over time—first in a tame release by the company and the FDA, and later in a devastating *Wall Street Journal* article. Following the first disclosure, the market price actually went up, not down. In finding the information to be immaterial, the Third Circuit held that "when a stock is traded in an efficient market, the materiality of disclosed information may be measured *post hoc* by looking to the movement, in the period immediately following disclosure, of the price of the firm’s stock." Because there was no adverse market reaction following the first disclosure, the court deemed the information “immaterial as a matter of law.” The court’s holding operated on the fundamental assumption that the stock traded in an efficient market, so that "information important to reasonable investors is immediately incorporated into the stock price.”

Here, it is important to note again that statistical significance of a market reaction is not the same as the statistical significance of the underlying information (even assuming that the latter is a meaningful concept). As noted above, there may be statistically significant evidence that a particular drug gives rise to a number of side effects, but whether that evidence is material for the value of the company will depend on factors including the importance of the drug and the degree to which those side effects will affect the company through losses of future sales or lawsuits related to past sales. The Third Circuit applied an understanding of statistical significance when it held that the nondisclosure of the Fen-Phen AERs was immaterial because the manufacturer had stated that there was no conclusive link between the drugs and valvular heart disease. Here, the Third Circuit correctly equated a lack of statistical significance (the underlying fact) with inconclusive results (the statement by the company). As we point out, however, statistically insignificant AERs can still convey valuable, material information to the rational investor, which may result in statistically significant price changes. Thus, it can be said that the company did not make a misstatement in this instance, but arguably did not disclose information that would have been material to the market. Indeed, in *Oran*, the revelation of the Fen-Phen AERs in the later *Wall Street Journal* article resulted in a statistically significant stock price decline.

We return once more to our three themes to consider the promises and pitfalls of the market reaction standard. First, it offers companies a large degree of certainty because stock prices are public, objective, quantifiable, and companies are familiar with how they work. It is also relatively easy to measure the statistical significance of stock price data, although there may be disputes on how to do so, but those price changes can only be measured *ex post*, after information is disclosed, making it difficult for companies to know *ex ante* whether to disclose information without actually doing so.

Second, the market is not necessarily rational, though plaintiffs will have to ultimately allege and prove that the market for a given security is rational (a requirement for market efficiency in the academic literature) for them to pursue a class action under the fraud-on-the-market theory. In *Oran*, the Third Circuit embraced *TSC* and *Basic’s* endorsement of the rational investor when it dismissed the alleged "spin" that the pharmaceutical company placed on its initial public disclosure. Thus, the court implicitly assumed that investors can accurately segregate any biases that accompany the delivery of information, thereby placing great faith in the "integrity of the price set by the market." In contrast, the Third Circuit then ignored the precipitous stock price decline following the *Wall Street Journal’s* revelation of the Fen-Phen AERs, which may have been due to a bias-laden headline effect, although it did so on other grounds.
Third, it is unclear what effect the market reaction test would have on the costs of disclosure. On the one hand, it may reduce costs because the market might consider the universe of material information to be much smaller than judges and juries do. On the other hand, however, it may increase costs because investors rationally care about what consumers care about, but what consumers care about may be irrational, subjective, and insignificant—both statistically and practically.

**Conclusion—Practical Guidance to Litigators and the Courts**

Statistical significance can be a useful tool to help litigators and courts examine materiality. The first step to using the tool is, of course, to understand what statistical significance does and does not show. As discussed above, statistical significance sheds a light on how unusual certain results or data are, and specifically how unlikely it would be to see such results if there were no true causal effect or relationship present. Statistical significance, however, does not go to the magnitude of an effect, a concept referred to by terms such as practical, economic, or clinical significance. Consequently, depending on the type of data being examined, statistical significance has different implications for whether information would be material for investors.

Before the information is disclosed, one cannot measure its effects on stock prices. However, one may be able to examine whether the information is statistically significant in the context of what it is measuring, such as whether the number of adverse event reports is unusually high given the type and amount of product sold. By itself, this analysis cannot tell us whether the information would be material for investors, as different types of adverse events may not have the same financial impact. Even a statistically significant financial change may not imply materiality for a stock price, particularly if the financial item being measured has little impact on a company's profits and cash flows.

On the other hand, just because something is not statistically significant from a medical or even financial point of view does not mean that it would necessarily be immaterial to investors. Early information, such as adverse event reports or preliminary medical studies that may not have enough power to yield statistically significant results for somewhat unusual effects, may increase the likelihood that an effect will later be proven, perhaps even with a statistical analysis that yields a statistically significant result. If investors were to recognize the increased probability that something may later be discovered, that could change their current valuation of the company’s stock price.

Finally, one of the standard tools in securities fraud cases is the analysis of whether a security’s price movement is statistically significant. Unlike the analysis of underlying data, this is a direct analysis of the item—the change in the value of a security—whose materiality is of concern in a securities fraud case. Again, statistical significance goes only to whether the movement is unusual, meaning that a movement of such a magnitude would be unlikely to be caused by random price fluctuations in the absence of some new (and material) information. Consequently, we can only infer the materiality of the information from the unusual movement of the price of the security. Statistical significance also does not address whether that movement is independently large or small, only whether it is large relative to the other price movements we observe. Perhaps by default, courts seem to have treated statistical significance as being the same as materiality, a result that we argue may be reasonable if a failure of statistical significance means that plaintiffs will not be able to prove materiality while a statistically significant daily price movement will be a reasonably large movement for most securities.
End Notes

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1 For purposes of disclosure, we note that Dr. Tabak was an expert in this case; that his reports described statistical significance with citations to the Reference Guide on Statistics; and that he was retained by a group of law firms including Mr. Lee’s firm, Boies, Schiller & Flexner LLP. Mr. Lee, however, was not involved in this matter.


3 Note again that the degree of “sufficient contrary evidence” in a criminal matter need not be the same as the evidence needed to achieve statistical significance at the 5 percent level.


5 Basic Inc. v. Levinson, 485 U.S. 224, 232 (1988) (“We now expressly adopt the TSC Industries standard of materiality for the § 10(b) and Rule 10b-5 context.”).

6 TSC Industries, 426 U.S. at 448–49.

7 Facially, the Court’s statement is contrary to its adoption of the theory of the rational investor. Under the simplest versions of rational choice theory, rational investors should have the unbounded ability to assimilate all available information and accurately parse trivial from nontrivial information. In contrast, under a behavioral model, investors have a limited ability to assimilate and parse information, so we would worry about burying the investor in too much information. However, the Court’s statement comports with its adoption of the rational choice model if one considers the high costs of information assimilation, which is consistent with the rational choice model.

8 Basic, 485 U.S. at 232.

9 Id. at 238 (quoting SEC v. Texas Gulf Sulphur Co., 41 F.2d 833, 849 (2d Cir. 1968)).

10 This assumes that such measurements are even possible given the non-systematic nature in which AERs are collected.

11 See infra Section II.D.

12 Basic, 485 U.S. at 236.

13 Id. at 234.

14 Id. at 231.

15 228 F.3d 154, 161 (2d Cir. 2000).

16 Id.

17 Under the semi-strong form of the efficient market hypothesis, an efficient market impounds all relevant, publicly available information, but not private information.

18 The courts of appeals currently are split on whether the absence of a statistically significant market reaction is dispositive of the element of materiality. Compare Oran v. Stafford, 226 F.3d 275 (3d Cir. 2000) (applying market reaction as per se rule of materiality in efficient market), with No. 84 Employer-Teamster Joint Council Pension Trust Fund v. Am. West Holding Corp., 320 F.3d 920 (9th Cir. 2003) (declining to adopt Oran’s market reaction rule of materiality).

19 226 F.3d 275.

20 Id. at 282.

21 Id. (internal quotation marks omitted) (quoting In re Burlington Coat Factory Securities Litigation, 114 F.3d 1410, 1425 (3d Cir. 1997)).

22 Id. (internal quotation marks omitted) (quoting Burlington, 114 F.3d at 1425).

23 The Third Circuit stated: Plaintiffs do not allege that the European data and adverse reaction reports, taken by themselves, established any statistically significant relationship between AHP’s products and valvular heart disease . . . . Because the link between the two drugs and heart-valve disorders was never definitively established during the relevant period even after the withheld data is taken into account, AHP’s failure to disclose this data cannot render its statements about the inconclusiveness of the relationship materially misleading. Id. at 283–84.

24 The Third Circuit, however, dismissed this stock price drop because it held that the company had no duty to disclose the AERs. Id. at 285–86.


26 Id. at 283.

27 Basic, 485 U.S. at 245.

28 See supra note 24 (noting that Third Circuit dismissed later stock price drop following WSJ article on grounds that company had no duty to disclose AERs).
About NERA

NERA Economic Consulting (www.nera.com) is a global firm of experts dedicated to applying economic, finance, and quantitative principles to complex business and legal challenges. For half a century, NERA’s economists have been creating strategies, studies, reports, expert testimony, and policy recommendations for government authorities and the world’s leading law firms and corporations. We bring academic rigor, objectivity, and real world industry experience to bear on issues arising from competition, regulation, public policy, strategy, finance, and litigation.

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