# The Economics of Enterprise Risk Management

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## Abstract

Enterprise risk management (ERM) models have grown in number and sophistication over the past few decades. However, few ERM models use tenets from economics to provide practical guidance that can help firms avoid “black swans” and other risky events.

Within this paper, we take an applied approach to examine the economics of ERM. We provide readers with a series of economically based warning signs that might signify significant changes in asset prices. These warning signs are based on the economic concepts of elasticity of demand, elasticity of supply and herd behavior. Our recommendations provide practical guidance to directors, executives and practitioners regarding ways in which they can mitigate risks in today’s volatile environment.

## 1. Introduction

Now in the midst of the "Great Recession," many of us still have unanswered questions about how we arrived at our current state and how sophisticated ERM procedures missed detecting the once-looming crisis. While new risk management papers, models and ideas have been constructed in decades past, these newly devised models (and their predecessors) failed to successfully shepherd businesses through the past two years. We feel that the reasons for this are twofold: 1) many risk management models are based on extremely complicated mathematical calculations that are often difficult to comprehend by directors and senior-level executives; and 2) these complicated, seemingly exact models, may have falsely comforted decision makers who believed their models' complexity implied high levels of accuracy and precision.

As such, within this paper we reject the use of complicated mathematical models in favor of devising a set of heuristics for management, executives, directors and practitioners. These heuristics are based upon topics from the economics literature, which, to our knowledge, are rarely discussed within risk management circles.

We wish to note that the heuristics we propose are based purely on economic fundamentals. There certainly exist numerous shocks that firms can endure as a result of changes in government regulation, natural disasters or other forces. The mitigation of these risks is not the focus of this paper.

In the proceeding sections, we will introduce the reader to the economic notions of elasticity and herd behavior. We will subsequently present theoretical and empirical arguments demonstrating the ways in which both phenomena have influenced the marketplace, and also provide the reader with insight into how they can be used in ERM.

## 2. The Economics of ERM

Risk itself is not inherently a bad thing. In fact, an old adage in finance states that, "without risk, there is no reward." However, while many firms actively evaluated the risks they bore prior to the economic crisis, these analyses generally failed to accurately assess risks, leaving companies unknowingly overexposed to risks for which they were not prepared.

Risk taking is a necessary part of decision making in an uncertain world. Investors each possess their own thoughts regarding future asset prices. No one can say with certainty whether the price of a stock will go up or down, but one can certainly present evidence supporting a conclusion on the issue. In a similar manner, businesses do not know with certainty the exact quantities in which products might sell, but they must make predictions in order to earn a profit and deliver returns above the risk-free rate for investors.

The element of uncertainty described above is exactly what ERM must address. ERM policies and procedures should be designed to:

- Perceive pertinent pieces of information;
- Aggregate this information while maintaining *Information Integrity*[1]
- Analyze the information;
- Formulate conclusions based on the information;
- Act on these conclusions.

There would be no need for ERM if certainty existed in the marketplace. Unfortunately, however, uncertainty abounds on many fronts and, as the recent economic crisis has demonstrated, can prove devastating for firms and individuals that do not fundamentally grasp the economic factors that underlie crises.

Until this point, risk management models have largely focused on modeling risks through complicated mathematical models. However, while many of these models are mathematically sophisticated, few endogenize key economic variables like the market price and quantity demanded of goods. Even fewer models are comprehensible by the average individual. Lacking economic analysis and intuition, firms are left to rely on models that might be hard to understand, thus clouding the decision-making process.

In the next section we hope to fill this gap in the risk management literature. We introduce the notion of elasticity and highlight its importance in ERM. We subsequently discuss herd behavior and its implications on elasticity. Together, these two fundamental economic concepts can provide readers with some much-needed intuition and guidance for use in ERM policies and procedures.

[1] We define *Information Integrity* as the process of preserving information in its original state without subjective manipulation.

## 3. An Introduction to Elasticity

One important element practitioners should consider in performing risk analyses is the *elasticity* of both demand and supply for products.[2] Elasticity is a term frequently used by economists, but infrequently used in the risk management world. In short, elasticity is a dimensionless quantity that represents the ratio of the percent change in one variable to the percent change in another variable.

While the term applies to many concepts, the *elasticity of demand*, $E_d$, is one of the most frequently discussed quantities within the field of economics. This quantity can be expressed as

$$E_d = \frac{\Delta Q/Q}{\Delta P/P},$$

where $Q$ and $P$ represent the quantity of goods sold and the price of goods sold, respectively. Notice that the elasticity of demand is calculated as the ratio of percent change in quantity demanded over the percent change in the price of the good. As such, elasticity has no units.

The *elasticity of supply*, $E_s$, can also be calculated as

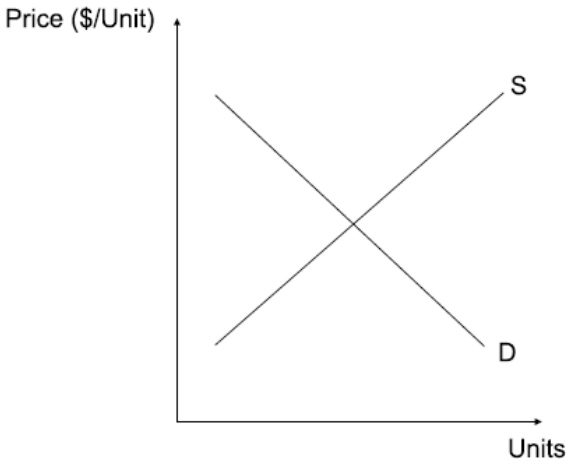
$$E_s = \frac{\Delta S/S}{\Delta P/P},$$

where $S$ represents the quantity of goods supplied to the market.

When discussing supply and demand, economists typically plot supply and demand curves with price on the vertical or Cartesian $y$ axis and quantity on the horizontal or Cartesian $x$ axis as shown in Figure 1. Within this figure, note that the supply of goods to the market is increasing in price while the demand for goods is falling in price. This agrees with our intuition, which suggests that demand will fall as prices increase, while firms will be more inclined to supply goods to the market when prices are high.

[2] The authors wish to acknowledge Lones Smith, professor of Economics, University of Michigan, for his keen insights in this section. Any errors, however, are regrettably our own.

**Figure 1**
**Sample Demand and Supply Curve**

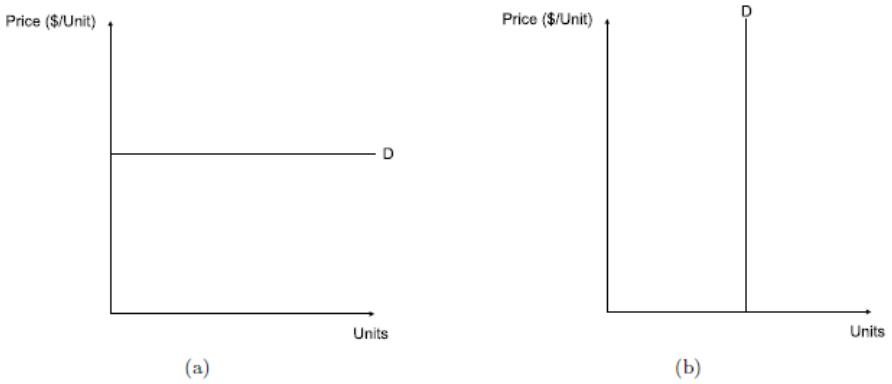



Shifting our focus to elasticity, we define an *elastic good* as one whose demand is highly sensitive to changes in its price; an *inelastic good* is one whose demand is largely insensitive to changes in its price. Figure 2 presents a side-by-side comparison of perfectly elastic and perfectly inelastic demand. In the perfectly elastic case, the quantity demanded by the market shifts to zero for even the slightest change in price. For example, airline tickets are elastic goods. If an airline raises the price of its ticket, consumers are likely to switch to an airline that offers a lower fare: the availability of numerous substitutes causes demand to be elastic. Other discretionary goods such as TVs and computers also have high elasticity of demand.

In the perfectly inelastic case, the quantity demanded by the market is the same irrespective of the price the good commands. The demand for water in arid regions, baby formula, diapers and insulin all represent inelastic goods.

Similar terms apply for elasticity with respect to supply.

**Figure 2**
**Comparison of Perfectly Elastic Demand (Left) and Perfectly Inelastic Demand (Right)**



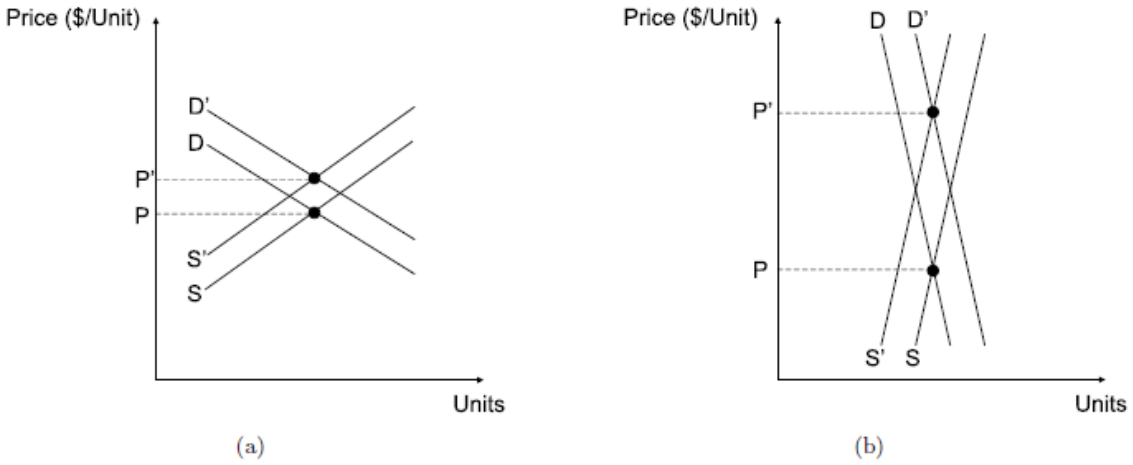
We will now employ this notion of elasticity to ERM, and describe the insights it may offer professionals looking for early warning signs to mitigate risks.

## 4. Using Elasticity in ERM

In the past few decades, we have seen the boom and bust of several asset price cycles: the dot-com, real estate, commodity price and leverage bubbles have come and gone, the latter three occurring in a relatively short period of time (2003–2007). Few would argue that the real estate and leverage cycles had profound effects on the wealth of many individuals and businesses. Within the United States, numerous financial institutions and manufacturers required significant government bailouts in order to keep these firms afloat. However, what allowed so many bellwethers of the U.S. economy to collapse so quickly? How could prices rise and fall so rapidly in such a short period of time? A potential answer lies in the notion of elasticity.

Figure 3 presents a comparison of two scenarios. In Figure 3a, demand (*D)* and supply *(S)* curves are elastic: in other words, the percent change in the quantity demanded by and supplied to the market is highly sensitive to the percent change in the price of goods in the market. This is reflected graphically in Figure 3a by the horizontal nature of the lines. In contrast, the demand and supply curves in Figure 3b are inelastic: the percent change in the quantity demanded by and supplied to the market is not sensitive to the price of goods in the market.

**Figure 3**
**Comparison of Price Changes When Demand & Supply Curves are Elastic (Left) and Inelastic (Right)**



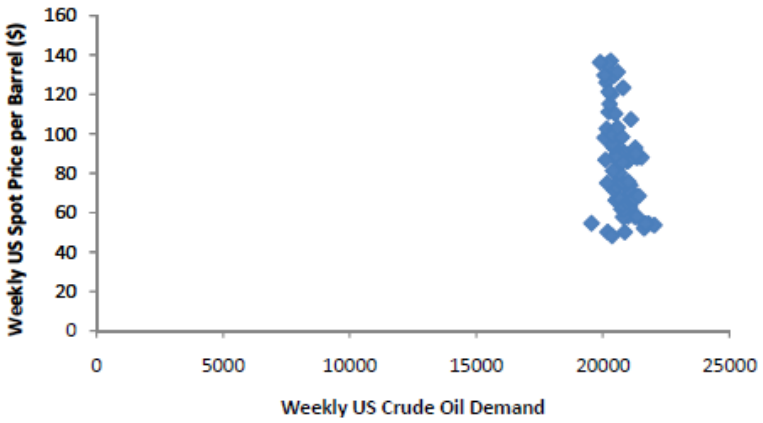

Let's suppose that the demand and supply curves for a particular good are initially represented by *D* and *S*, respectively. In this case, demand and supply intersect at a price *P*. However, if both the demand and supply curves shift upward, with demand switching to $D'$ and supply to $S'$, the intersection of these two curves now occurs at price $P'$. Note that the magnitude of the shift in the demand and supply curves, as represented by the distance between two similar curves, is constant across Figures 3a and 3b. While in both cases the new price $P'$ is higher than the initial price *P*, the change in price is much greater when both demand and supply curves are inelastic than when they are elastic. This change in price can be measured by the vertical

distance between points $P$ and $P'$. Clearly, the elasticity of supply and demand heavily influence the vertical distance between $P$ and $P'$.

The elasticity of demand and supply curves holds significant implications for ERM practitioners looking for early red flags to help mitigate risks. In brief, ERM practitioners need to be wary in instances where (i) consumer behavior is insensitive to price and (ii) industry-level production is unresponsive to price. When these two conditions are present, a scenario akin to that shown in Figure 3b exists and the potential for high price volatility is present.

For example, consider Figure 4, which plots the demanded quantity versus price for U.S. crude oil from January 2007 through July 2008. Here, we use the U.S. Energy Information Administration's (EIA) "Petroleum Products Supplied" as a proxy for overall U.S. crude demand (this selection was made per the suggestion of the EIA). During this time period, the U.S. spot price per barrel of crude oil rose from a weekly average of $55 per barrel to $135 per barrel; however, the percent change of crude oil demanded by the market was very small relative to the percent change in price of crude oil. As such, the demand for crude oil during this time period was inelastic.

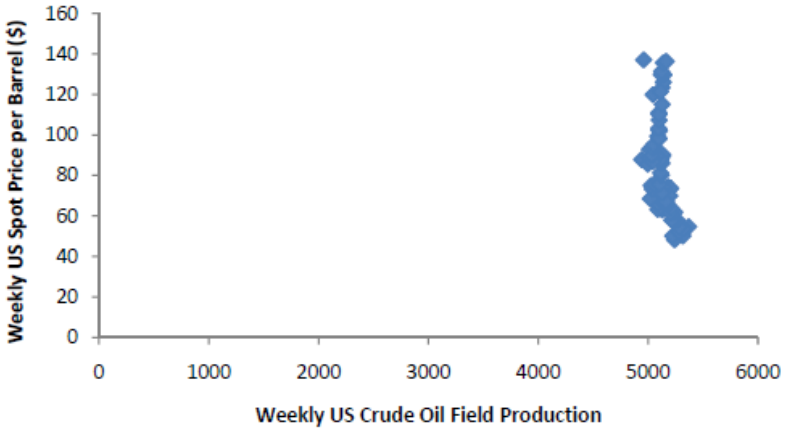
**Figure 4**
**Weekly US Spot Price per Barrel vs. Weekly US Crude Oil Demand as Measured by Petroleum Products Supplied, Jan 2007 – Jul 2008**




Source: US Energy Information Administration.

Likewise, in Figure 5, we have plotted the weekly supply of crude oil as measured through U.S. Crude Oil Field Production. The supply curve for crude oil is also highly inelastic. Because both the demand and supply of crude oil were highly inelastic during this time period, the price of crude oil was able to shift markedly in response to even the slightest changes in supply and/or demand, similar to Figure 3b. Had either the demand or supply curve been more elastic, significant price changes would not have been possible without large shocks to demand or supply.

**Figure 5**
**Weekly US Spot Price per Barrel vs. Weekly US Crude Oil Field Production, Jan 2007 – July 2008**




Source: US Energy Information Administration.

## 5. Herd Behavior and its Implications for ERM

In the early 1990s, a literature was developing within the field of economics that sought to explain the manner in which individuals were influenced in their decision making by their peers. Though now well established within economics, to our knowledge, this literature has yet to be applied to ERM.

Classical economic theory has long held that investment decisions reflect agents' rationally formed expectations. Nonetheless, some economists, including John Maynard Keynes, were skeptical that investors would base their decisions purely on their own personal beliefs. In Keynes' words:

> *"the long-term investor...should be eccentric, unconventional, and rash in the eyes of average opinion. If he is successful, that will only confirm the general belief in his rashness; and if in the short-run he is unsuccessful, which is very likely, he will not receive much mercy. Worldly wisdom teaches that it is better for reputation to fail conventionally than to succeed unconventionally."*

With these words, Keynes suggested that investors, concerned about how others will assess their behavior, will make decisions that follow the "herd" of behavior, rather than act against it.

To further explore the notion of herd behavior, consider the following example proposed by Banerjee (1992).[3] There exist two restaurants, A and B, with entrances immediately next to each other. Imagine that 100 customers form a single-file line at both restaurants before selecting whether to dine at Restaurant A or B. All customers are able to observe the choices made by individuals that are ahead of them in line.

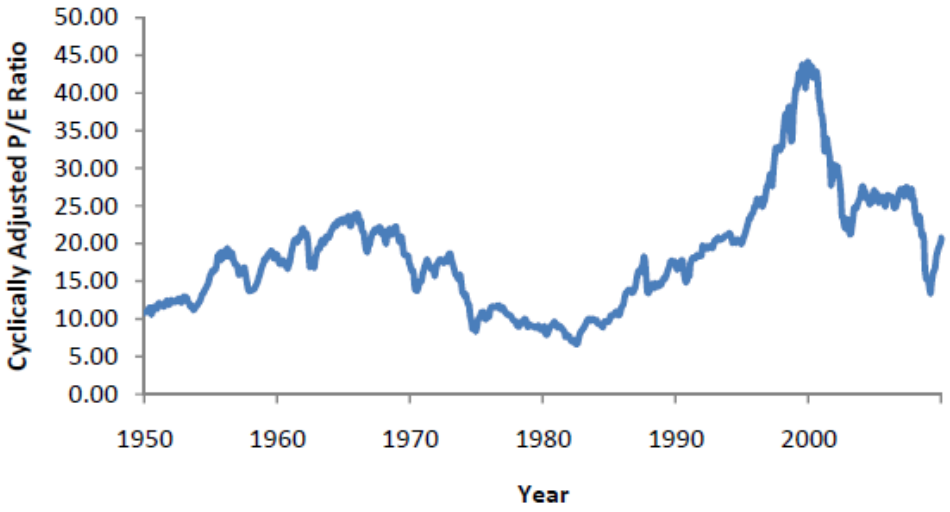
Let's suppose that all consumers have a prior belief that Restaurant A is better than Restaurant B with a 51 percent chance. However, in addition to possessing this prior belief, consumers also receive an individual signal (known only to them) about which restaurant is better. We assume all of these signals are identically distributed.

Let us further suppose that 99 out of the 100 customers in line receive a signal that Restaurant B is better than A. However, the first customer in line receives the lone signal that A is better. If this is the case, this individual will select to eat at Restaurant A. The second person in line, having watched the first person select Restaurant A, will know that his predecessor received a signal that A was better. Thus, even though the second person received a signal that B was better, this signal is canceled out by the observation that the previous individual selected A. Therefore, the second customer will base his decision on the prior probabilities and select restaurant A *irrespective of his personal signal*. The third person in line faces a similar dilemma to the second person, and will again choose restaurant A. Thus, even though 99 customers received a private signal that Restaurant B was the better restaurant, everyone ends up at A.

[3] Banerjee, A. "A Simple Model of Herd Behavior." The Quarterly Journal of Economics 107(3): 797–817.

While this example seems rather trivial in nature, it helps explain the decisions of firms and individuals participating in a market. Many of us remember the "irrational exuberance" that came over investors during the dot-com boom of the late 1990s. As shown in Figure 6, the price-to-earnings (P/E) ratio of S&P 500 stocks during this time period exceeded 40, nearly three times the trailing 50-year historical average. Nonetheless, investors continued to pour money into stocks until the bubble crashed in early 2000, sending shares of many stocks plummeting.

**Figure 6**
**Cyclically Adjusted Price-to-Earnings Ratio of S&P 500 Stocks**
**Jan 1950 – Jan 2010**




Source: Robert J. Shiller.

One potential explanation for the extreme boom and subsequent bust of asset prices during this time is that of changing demand elasticity due to herd behavior. During the late 1990s, owning stocks and talking stocks was *en vogue*. The number of stock clubs within the United States tripled during the five-year period of 1994 through 1999.[4] Even as stock prices continued to rise, the demand for stocks remained strong—consumer behavior had arguably rotated the demand curve for stocks to one that was more inelastic. This shift to an inelastic demand set the stage for the rapid price appreciation and subsequent price falls described in a previous section and shown in Figure 3b.

As such, herd behavior is a significant factor that ERM policies and procedures must combat. Herd behavior encourages shifts in the elasticity of demand curves (for consumers) and supply curves (for firms). It allows individuals (or firms) to rationalize greater demand (or supply) even as prices continue to climb. It also sets the stage for future collapse once the tide turns, for demand and supply need only shift slightly for prices to crater.

ERM managers must be on the lookout for such scenarios where both supply and demand of goods are highly inelastic. They must also watch for signs that consumers and firms are

[4] Daragahi, B. "How to Start an Online Stock Club." Money 28(8): 115–117.

becoming increasingly insensitive to changes in prices. These scenarios can be present once herd behavior starts to manifest itself.

Though firms cannot readily control herd behavior among consumers, they can attempt to combat it within the firm. One of the best ways to combat herd behavior at the firm level is to incentivize employees to listen to their own private signals when making decisions, rather than simply following the behavior of others. Firms can provide such incentives to employees in numerous ways. The first way to incentivize employees to rely on their personal signals is to set a proper "tone at the top" which encourages employees at all levels to "succeed unconventionally" rather than "fail conventionally."

Establishing such a tone at the top might be especially difficult in organizations that are highly risk-averse. In general, such risk-averse organizations will not tend to be "first movers" in the industries in which they participate; they will generally wait for another firm to test out a potential market before delving into it themselves. While this practice has few issues for firms that participate in relatively stable markets, such behavior can potentially cause the firm to act only upon decisions that are made by the "herd." In the end, while the firm might believe such a practice allows it to minimize its risk exposure, the firm may, instead, be *overexposing* itself to risks of rapid price changes due to inelasticity.

In recent years, many scholars and practitioners have been advocating merit-based pay for employees that is based, in part, on a firm's performance relative to its competitors. However, while a seemingly well-intentioned practice, such compensation schemes can also encourage herd behavior among employees. For instance, many have made the argument that leaders of financial institutions took too many risks in the late 2000s, overexposing their firms to short-term risks that would not generally have been tolerated. However, in an environment where excessive risk taking was fast becoming the norm, bank executives were encouraged to join the "high-risk herd" in order to deliver returns exceeding those of their competitors. In fact, the debt-to-equity ratios of Goldman Sachs, Merrill Lynch, Bank of America, JP Morgan and Morgan Stanley rose by an average of nearly 50 percent between the end of calendar year 2006 and 2007, immediately preceding the financial crisis.[5] Not one of these large banks deleveraged their balance sheet during this time, likely because each was employing leverage to drive returns and outdo its competitors. Instead, their managers "joined the herd" and followed its behavior. The end result of such excessive leverage was nothing short of disastrous for the financial system and the economies of many nations around the globe.

[5] Authors' analysis of data from Center for Research in Security Prices (CRSP).

## 6. Key Suggestions for Mitigating Risks

Having discussed the economics of ERM, we close by reiterating the following key suggestions for mitigating risks.

1. Be wary when demand and supply are inelastic.

   We have shown both theoretically (through graphical analysis) and empirically (through an analysis of U.S. crude oil prices) how inelasticity of supply and demand curves can lead to sharp changes in prices. As such, firms must be on the lookout for changes in consumer behavior and also changes in competitors' behavior that signify increasing inelasticity of the demand and supply curves, respectively.

2. Listen to private signals.

   Too often firms base their behavior on the actions of others. While this philosophy may work in the short term, it may also leave the firm overexposed to risks for which it has not accounted. Behaving with such a herd mentality can seem harmless, until it's too late. Rather than follow the herd, firms should follow their private signals regarding investment decisions. They should never enter into activities that their employees privately and collectively believe are a poor idea.

   It is, in fact, this philosophy that guided Peter Lynch, manager of Fidelity Investments' Magellan Fund from 1977 to 1990, throughout his investment career. Over his tenure the Magellan Fund delivered average annual returns of nearly 30 percent.

3. Reward employees for unconventional thinking.

   Establishing a proper tone at the top that encourages risk taking can assist firms in mitigating risks associated with herd behavior. By encouraging employees to "succeed unconventionally" rather than "fail conventionally," firms can properly incentivize employees to avoid the herd mentality and, instead, devise creative, unique solutions to deliver returns required by shareholders.

Adherence to these aforementioned economics-based tenets can assist firms in mitigating the numerous risks they face in today's global environment.