Risk pricing practices in finance, insurance and construction

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1. Abstract

A review of current risk pricing practices in the financial, insurance and construction sectors is conducted through a comprehensive literature review. The purpose was to inform a study on risk and price in the tendering processes of contractors: specifically, how contractors take account of risk when they are calculating their bids for construction work. The reference to mainstream literature was in view of construction management research as a field of application rather than a fundamental academic discipline. Analytical models are used for risk pricing in the financial sector. Certain mathematical laws and principles of insurance are used to price risk in the insurance sector. Construction contractors and practitioners are described to traditionally price allowances for project risk using mechanisms such as intuition and experience. Project risk analysis models have proliferated in recent years. However, they are rarely used because of problems practitioners face when confronted with them. A discussion of practices across the three sectors shows that the construction industry does not approach risk according to the sophisticated mechanisms of the two other sectors. This is not a poor situation in itself. However, knowledge transfer from finance and insurance can help construction practitioners. But also, formal risk models for contractors should be informed by the commercial exigencies and unique characteristics of the construction sector.

Keywords: construction sector, financial sector, insurance sector, risk, risk pricing.

2. Introduction

This paper aims at appraising the theory and practice of risk pricing practices in the finance, insurance, and construction sectors through an extensive literature review. The construction sector is often responsible for the development of the built environment. The insurance sector mainly undertakes to bear risks for a premium. The finance sector oversees the inward and outward flow of financial resources. Practitioners in these sectors encounter risk daily. Thus, the quantification of risk is often necessary to keep the business going. There are various definitions of risk, some of which are discussed under the succeeding sections. However, there seems to be significant agreement on the fact that risk is focused on deviations from expected outcome. Risk attitudes differ. Some people and organisations are risk loving while others are either risk neutral or risk averse. For many years, researchers have tried to clarify and understand how humans respond to risks and dangers. However, disagreements still exist on the issues relating to definitions and what constitutes risk. Risk is generally focused on deviations from expected outcomes. However, to date, there is no SI unit for risk.

3. Risk pricing in the finance sector

In the finance literature, risk is synonymous with uncertainty. Risk arises because the future is unknown. For instance, default risk represents the future possibility that a party will default on a contractual obligation. Regulatory risk refers to the possible future imposition of rules, laws or regulations that will impede doing business. Somewhat related is accounting risk, which would alter the way in which transactions are accounted for and reported in financial statements. Legal risk is the risk that contracts terms will prove to be unenforceable. Price risk could arise because of prices of goods/components fluctuating in unpredictable ways in the future. Portfolio theory and capital market theory stipulate that the total risk is comprised of systematic risk and unsystematic risk. These forms of risk are also very fundamental to the construction and insurance industries. What is important to understand is that the future is unpredictable. Individuals dislike risk. Owners of construction companies, financial securities and investors are risk averse. Risk management then becomes important in reducing (or possibly eliminating) uncertainty via hedging, or purchasing forward to protect against unfavourable outcomes.

Risk perception and its measurement have been achieved through varied means in economics and finance. The real world is sufficiently complex that to understand it and construct models of how it works one must assume away. One research endeavour that enlivens the debate about how risk is treated is the idea of the capital asset pricing model (CAPM) of Sharpe (1964), Lintner (1965), and Mossin (1966). Given certain simplifying assumptions, the CAPM states that the rate of return on any security is linearly related to that security systematic risk (or beta) measured relative to the market portfolio of all securities. The CAPM assumes for example that, investors have the same information, and this information is costless to gather and process. In addition, there are no taxes, transactions cost, or other frictions. It also assumes that investors can borrow and lend at the risk free rate of interest. Hence, according to the CAPM, cross sectional relation between risk and return can be expressed as:

$$E(R_j) = R_f + \beta_j \lfloor E(R_m) - R_f \rfloor$$

Where $E(R_j)$ and $E(R_m)$ are expected returns to asset *j* and the market portfolio respectively, R_f is the risk free rate (it could be a treasury bill or any other riskless asset) and β_j is the beta coefficient. The beta coefficient measures the tendency for asset *j* to covary with the market portfolio. It represents the part of the assets risk that cannot be diversified away, and is the risk that investors are compensated for bearing. The CAPM equation thus postulates that, the expected return of any risky asset is a linear function of its tendency to covary with the market portfolio. So, if the CAPM is an accurate description of the way assets are priced, and hence risk, this positive linear relation should be observed when average portfolio returns are compared to portfolio betas. Moreover, when beta is included as an explanatory variable, no other variable should be able to explain cross sectional differences in average returns. This is how risk has been perceived in finance for a long time.

The CAPM is appealing in its elegance and logic especially in context of its math. However, empirical tests of the model often raise doubts about its underlying assumptions. See Brenan (1970) and Litzenberger and Ramaswamy (1979) who relaxed the no tax assumption. Also, see Breeden (1979) Merton (1973) for further extensions of the CAPM. Ross (1976) developed an entirely new model called the Arbitrage Pricing Theory. Our concern in this section is to examine how risk is priced in finance as opposed to other fields such as construction and insurance industries. Clearly, the model's focus on market rather than total risk is a useful way of thinking about the usefulness of assets in general. But, it is unknown precisely how to measure any of the inputs required to implement the CAPM. These inputs should all be ex ante, yet only ex post data is usually available. Historical data for R_m and betas vary greatly depending on the time period studied and the methods used to estimate them. Such estimates in the CAPM are, therefore, subject to potentially large errors.

Furthermore, a growing number of studies suggest that betas of common stocks do not adequately explain cross sectional differences in stock returns. Instead, a number of other variables such as firm size, ratio of book to market, earnings/price, that have no basis in extant theoretical models seem to have significant predictive ability. For example, Basu (1977) and Banz (1981) found that the ratio of price to earnings and market capitalisation of common equity, respectively, provided considerably more explanatory power than beta. These two seminal papers served as a springboard for much subsequent research that confirmed the ability of variables other than beta, to explain cross sectional differences in returns. Absent in this literature, though, is any supporting theory to justify the choice of variables. Nevertheless, these findings collectively represent a set of stylised facts that stands as a challenge for alternative asset pricing models.

The finance industry has advanced in the way risk has been managed over the past two decades. A leap forward in the way of managing risk other than just the beta of portfolios is now commonplace. One avenue through which risk has been dealt with is the use of derivatives. A derivative is a financial contract whose value is 'derived from' or depends on the price of some underlying asset. Equivalently, the value of a derivative changes when there is a change in the price of the underlying related assets. A number of these instruments are widely available for risk management purposes, but four will suffice here - forwards, futures, swaps and options. A forward contract gives the owner the right and obligation to buy a specified asset on a specified date at a specified price. The seller of the contract has the right to sell the asset on the date for that specified price. At delivery, ownership of the good is transferred and payment is made. In other words, whereas a forward contract is originated today, and the price is agreed upon today, the actual transaction in which the underlying asset is traded does not occur until a later date. A futures contract has a similar arrangement except that futures are traded on organised exchanges and they are more liquid than forwards. Swaps are contracts between two parties to exchange cash flows at future dates according to prearranged formula. Finally, option is a contract entitling the holder to buy or sell a designated security at or within a certain period of time at a particular price. Our concern here is to show how these derivatives are used in managing risk. For rigorous discussion of these instruments, readers are referred to Rubenstein (1983), Brenan (1986) among others in the finance literature. There has been a huge explosion in derivatives and in 1999 the market was estimated to be worth $88 trillion, thus making it difficult to justify any ignorance of such instruments in any risk management enterprise.

Different groups of people use derivatives to achieve varied objectives. Speculators who think they know the future direction of prices use derivatives to try to profit from their beliefs. Arbitrageurs trade derivatives to take advantage of perceived miss pricing. Hedgers face the risk that a change in a price will hurt their financial status; they use derivatives to protect, hedge, or insure themselves against such harmful movements in prices. Of particular interest is the current indispensability of derivatives for accomplishing many tasks necessary to the successful management of corporations, construction projects, governments, and large pools of money in general: managing exposure to price risk, lowering interest expense, altering the structure of assets, liabilities, revenues, and costs, reducing taxes, circumventing unwieldy regulations that make transactions difficult and arbitraging pricing differentials.

4. Risk pricing in the insurance sector

Insurance industry experts do not always agree on definitions regarding risk. Many times, great legal battles have been required to resolve contentions relating to definitions in the insurance industry. In a financial sense, we can view insurance as a system where insured’s transfer their loss exposures to an insurance pool, and losses redistributed among members of the pool (Dorfman, 2002). Sustainability depends on certainty of financial payments from a pool with adequate resources and accurate predictability of the group’s losses. The cost of losses is financed by advanced redistribution among members based on such predictability by collecting a premium from every insured. The insurer then assumes risk for the insured's losses resulting from an insurable event; even though only a small percentage will actually suffer losses. Thoughts of large losses naturally scare most people; leading them to pay insurance premiums that are greater than the mathematically fair chance of loss to ensure certainty of compensation in an event of loss. However, not everyone behaves this way. Some people are risk seekers; they enjoy assuming their own risk. Others are risk neutral; they will pay to be relieved of risk but only at the mathematically fair price. In a legal sense, we can view insurance as a contractual agreement where the insurer agrees to compensate the insured for losses (Dorfman, 2002). Key terminologies emerging from this legal perspective are insurer (party agreeing to pay for losses); insured (party whose losses invokes a claim); premium (payment received by insurer from insured) and exposure to loss (the insured's possibility of loss). Rights and obligations are created for the parties when the insured purchases an insurance policy from the insurer and fulfils all the principles of insurance. Insurable events are characterised by conditions such as large number, accidental loss, large-loss principle, catastrophic loss, insurable interest, subsidisation and adverse selection.

Like many other fields, risk has no generally agreed definition in insurance. Dorfman cites the two commonly used definitions as: 'the variation in possible outcomes of an event based on chance' and 'the uncertainty concerning a possibility of loss'. The variability concept emphasises the statistical aspects of risk and insurance whilst the uncertainty concept emphasises the behaviour aspect of people exposed to risk. For any given situation, degree of risk is the measure of the accuracy with which we can predict the outcome of an event based on chance. Insurance risks are categorised as either pure or speculative. Pure risk results only in a loss or no change, whereas speculative risk results in either gain or loss. Effective risk analysis and evaluation therefore becomes the logical process used by firms and individuals to deal with their exposures to loss i.e. preloss planning for postloss resources. There are various branches of insurance (fire, business, income coverage, marine, casualty, bonding, life, medical expense, and disability), but risk premiums are calculated on the same principles. The conditions necessary for such evaluation is associated with words such as loss, chance of loss, peril, hazard, and proximate cause. Loss (insurable, direct and indirect) is the state of being without something previously possessed. Chance of loss (actual or ex post) refers to a fraction or possibility that creates a need for insurance. Peril is the cause of the loss. Hazards are conditions that increase either the frequency or severity of losses. Proximate cause of loss is the first peril in a chain of events resulting in a loss, without which step loss would have not occurred (Dorfman, 2002).

Thus, insurers charge a premium for the risk they assume in undertaking to restore insured’s from losses they suffer from insurable events. How do they arrive at a price for the risk premium? Practitioners of the insurance industry assess and price risks based on certain principles of insurance. Principally, they apply a mathematical principle called the law of large numbers. This law states that ‘the greater the number of observations of an event based on chance, the more likely the actual result will be approximate to the expected result.’ The success of insurance companies therefore relies heavily on accurate prediction of losses, and they often apply the techniques of formal probability theory to achieve this. The relative accuracy of a company’s prediction increases as the number of exposures in the insurance pool increases. One point Dorfman (2002) emphasises is that the law of large numbers only allows accurate prediction of group results; it hardly facilitates accurate prediction of the result of a particular exposure. Insurers use the predicted values of losses as basis for budgeting costs and sharing it in advance among insured’s. This evaluation results in the risk premium. Much often, many consumers and businesses are motivated to buy insurance by the apparent substitution of a small certain premium in place of a large uncertain loss.

Calculation of the risk premium is typically based on previous knowledge of the event of interest. For example, 100 Ghanaian contractors wishing to come together to form an insurance pool to protect themselves against the loss of their equipment from fire can systematically determine the price each member should pay for the risk of equipment loss from a fire event. They can learn from historical records how in the past, fire losses caused damage each year amounting to 1 per cent of the value of similar equipment i.e. some equipment was destroyed by fire, while others were only damaged partially. If each contractor has equipment worth $800,000, then 100 such equipment will have a value of $80,000,000. By applying the 1 percent equipment damage prediction, expected losses for the insurance pool will be equal to $800,000 (0.01 x $800,000).

Assuming that the insurance pool has no operating expenses, and that actual losses equals expected losses, and that no investment income is earned on premiums paid in advance, then the price of risk for likely equipment fire damage will be $800 per contractor. In an extended sense, it could come about that not every contractor's equipment will be worth exactly $800,000; may be less or more. Hence, one can also compute the cost of insurance based on each $100 of value. This results in $1. Thus, a contractor with $450,000 equipment would pay $450 as the price of risk for a one-year membership in the pool instead of $800, and a contractor with $650,000 equipment would be required to pay $650. This example is only facile, as calculation of the risk premium should also take account of other factors besides actual cost of losses. These include expense of operating and maintaining the insurance pool, allowance for unexpected losses, and earnings on investment. Because of earnings on investment, the price of risk can generally be smaller than the impact of risk. In a practice known as cash flow underwriting, some insurers can price their premiums below the level of expected loss in anticipation of investment earnings.

5. Risk pricing in the construction sector

Construction is often cited as a highly risk prone business because of the unique nature of the industry and its projects. These peculiar factors include necessity to price product before production, competitive tendering as a means of awarding work, low fixed-capital requirements, preliminary expenses, delays to cash-inflows, tendency to operate with too low a working capital, seasonal effects, fluctuations and their effects, Government intervention, activity related to development, uncertain ground conditions, unpredictable weather, no performance liability or long-term guarantees, etc (Calvert *et al.*, 1995). Construction projects are complex, have a long production cycle, involve the input of many participants, and must meet many standards and statutory regulations (Kwakye, 1997). The high business failure rates construction industry records may indicate that while the industry has learned to master building, it has yet to master risk.

For many years, practitioners of the industry have relied on unsystematic mechanisms such as intuition and in-house techniques to value allowances for risk when estimating. A survey of pricing strategies of the top 400 US contractors showed that: 'in setting the markup, contractors mainly rely on their intuition after subjectively assessing the competition' (Mochtar and Arditi, 2001). Contractors and other players in the construction industry largely apportion risk by simply applying a fixed percentage figure or lump amount to the base estimate of a project as an allowance for uncertainty. But this approach can hardly be considered as logical since sensible risk apportionment should correspond to the extent uncertainties in a project. The problems of arbitrary contingency allocation in capital budget estimates of public projects caused the Hong Kong Government to implement the Estimating Using Risk Analysis (ERA) technique in 1993 to serve as a logical means of apportioning risk allowances (contingency) in estimates (Mak and Picken, 2000). Generally, the construction industry has no systematised approach for analysing and evaluating project risks in practice. Theoretically, however, the evaluation mechanism for one measure of a project risk is the product of its probability and its impact. But Williams (1996) exposes the danger in comparing and combining risks in this way.

Construction risks are often perceived as events that influence the traditional project triple constraint objectives of time, cost, and performance (including quality). While risk is defined as: the exposure to the chances of occurrences of events adversely or favourably affecting project objectives as a consequence of uncertainty, the risk event is seen as what might happen to the detriment or in favour of the project (Al-Bahar and Crandall, 1990). In specific relation to construction, The Aqua Group (1990) define risk as 'the possible loss resulting from the difference between what was anticipated and what finally happened.' Common consequences of project risks are cost overruns, time overruns, poor quality, and disputes among the parties to a construction contract. Risk is an important issue to contractors as well as clients and consultants of the industry. However, the problems of risk assessment are complex and poorly understood in practice.

According to an RICS (2004) research report, industry practitioners tackle risk in five main ways. These are: (1) 'the umbrella approach' where you must allow for every possible eventuality by adding a large risk premium to the price; (2) 'the ostrich approach' where you bury your head in the sand and assume everything will be alright, that somehow you will muddle through; (3) 'the intuitive approach' that says don't trust all the fancy risk analysis, trust your intuition and gut feel; (4) 'the brute force approach' that focuses on the uncontrollable risk and says we can force things to be controlled, which of course they cannot; and (5) 'the snowboard approach' that says you are on a snowboard on the downhill run, you have pre-planned and analysed where all the pitfalls are by identifying the risks, having a risk register in your mind, and taking corrective actions. You can control some things such as speed and route but not others such as weather and the competition. Focus therefore on the actions needed to manage the risks throughout the run, arrive safely, and win through. In today's world, very few organisations can survive on the first four approaches. That probably explains why business failure is commonplace in the construction industry.

In recent years, formal and analytical risk models that contractors can incorporate into the bidding process to assess project risk have proliferated but they are unused in practice. Classical approaches such as probability theory and Monte Carlo simulation underpinned the development of earlier risk analysis models. Al-Bahar and Crandall (1990) proposed an influenced diagramming / Monte Carlo simulation approach to serve as a logical substitute for the traditional intuitive unsystematic approach used by contractors. Many other research endeavours such as Mak and Picken (2000) and Fang *et al*. (2004) have followed this. But the models have received low take-up in practice due to reasons espoused in Akintoye and MacLeod (1997), Smith and Bohn (1999) and Ahmed *et al*. (2002). More recently, risk models have shifted paradigm from classicalism towards conceptualism, with the main argument that much of the information required for the analyses can be obtained in linguistic but not numeric form. The conceptual models are underlined by mathematical theories such as fuzzy sets and neural networks. Examples in this include the fuzzy set model introduced by Paek *et al.* (1993) for pricing of the risk elements in a construction project, and another fuzzy set model Tah *et al.* (1993) introduced to assist contractors in project risks contingency allocation. These models have mainly had a theoretical instead of a practical orientation resulting in a low take up in practice. For instance, most risk models meant for contractors assume that contingency is a line item in the estimate. But this may not be true. When pricing work, contractors tend to spread risk on the various cost items in the bid. Again, most of the models omit a market or competition factor. Not only are contractors unable to price risks, but also where they can, they are often reluctant to include a price for risk in their bids because of competition.

The absence of analytical models in contractual practice may significantly not conclude that contractors are poor at dealing with risks as the literature generally portrays it. Since the origin of general contracting in the early parts of the 19th century, contractors have used various mechanisms to survive risks in the construction industry. Most contactors resorted to speculative house building in the 19th and 20th centuries to sustain labour force and business costs through the peaks and troughs of contracted work. In modern times, there is a growing tendency for contractors to use their positive cash flows to invest in projects, rather than house building. More recently, successful contractors are diversifying into businesses whose cycles counteract those of construction (Oxford Encyclopaedia of Economic History, 2003: 1: 511). Contractors are minimising risk by declining work perceived as too risky, subcontracting large portions of their work to others, and apportioning risk in wage structures. In essence, they are passing on risk to others. There is no systematic means of pricing risks in construction. However, when pricing, contractors intuitively adjust either the quantities or unit rates or both to reflect their uncertainty resulting from the unknown scope of works and the future.

Despite a low take-up in practice, the proposition of mathematical models for project risk analysis and evaluation proliferate the literature. The key features are qualitative assessment (to describe and understand each risk and gain an early indication of the more significant risks), and quantitative assessment (to quantify the probability of each risk occurring and its potential impact in terms of cost, time and performance). Formal recognition and assessment of risk has taken a leap forward in the construction industry over the recent past years. Field data in Laryea and Hughes (2006) found some large construction organisations in the UK employing some formalised analytical risk evaluation procedures to forecast risks. However, the predominant mechanism contractors use for assessing and apportioning risk is the application of their experience to directly / intuitively judge a percentage to apply to the base estimates. Contrary to what most risk models assume, contractor contingency is not a line item in the bid estimate. Consultants and other practitioners of the industry also apply fixed percentages of cost to allow for risks. This is the allowance, which is often a line item in the client's estimate. A few cases on the use of formal risk models are present. But the empirical studies of Akintoye and MacLeod (1997), Smith and Bohn (1999) and Ahmed *et al*. (2002) explain why a campaign for their wider use, especially among contractors, may be an elusive agenda.

6. Discussion of risk pricing approaches in the three sectors

The studies indicate that the construction, finance and insurance industries commonly relate the concept of risk to variability i.e. deviation from expected outcomes. Risk pricing is a relatively well-developed area in the field of finance. Formal and analytical techniques such as the CAPM, Arbitrage Pricing Models (APT), Earnings at Risk (EaR), Value at Risk (VaR), financial instrument pricing models, corporate financial modeling and real option and volatility modelling especially in the light of advances in applied financial econometrics (e.g. the use of generalised autoregressive conditional heteroscedasticity - GARCH - models) are employed in risk analysis and evaluation. Historical data are usually available to facilitate risk analyses. The use of traded options for instance has gained currency in recent time. Options can help the issuer of a stock trade some of the possible opportunity gain from a falling stock price for protection from the opportunity loss associated with a rising stock price. Correspondingly, an investor can use options to exchange some of her upside potential for downside protection. Convertible bonds and some equity offerings like preference equity redemption cumulative stock have risk-reallocating option provisions embedded in the security itself. Market makers can buy options for protection from large price movements in either direction. However, in the early to mid 1990s, series of corporate bankruptcies involving traded options laid bare the fact that the increasing reliance of derivatives as tools for managing risk could themselves prove risky. Nonetheless, the advancement regarding the way risk is perceived, formalised, analysed and managed in finance, hold significant ideas that could be employed in other fields. This is unlike the construction industry where risk analysis is based on intuition and experience. Because adequate statistical or objective information is not available, the data often has to be obtained from experts and persons with the relevant knowledge. In spite of this, however, risk perception, pricing and management could be seen as an integrated process by which different disciplines approach differently but the essential outcomes may not be fundamentally different. Financial analysts often build a required rate of return to comprise a riskless rate plus compensation for individual risk factors such as the purchasing-power-risk, business-risk, financial-risk, market-risk, and an allowance for 'other' risk. Similar classifications are given to risks in the fields of finance and construction. Both fields share the view that risks are either systematic (non-diversifiable) or unsystematic (diversifiable). Portfolio theory and capital market theory stipulate that the total risk is comprised of systematic risk and unsystematic risk. Project risk is often divided into internal risk (local and global) and external risk.

Table 1 Summary of findings on risk pricing practices

Theme	**Finance industry**	**Insurance industry**	**Construction industry**
Method of pricing risk	Systematic	Systematic	Unsystematic
Data required	Objective / statistical	Objective / statistical	Subjective / linguistic
Mechanism	Models (CAPM, APT, etc.)	Large loss principle	Intuition and experience
Contemporary approaches	Derivatives	Cash flow underwriting	Risk allocation
Terminology	Risk allowance	Premium	Contingency
Main activity	In and out flow of financial resources	Undertakes to bear risk	Built environment
Risk modelling	Developed	Developed	Emerging
Types of risk	Systematic and unsystematic	pure and speculative	Internal and external

For the insurance industry, risk is business as usual. They embrace the risk, and charge the insured a premium. The insurance industry can relatively be considered as developed when it comes to risk pricing. They use formal mechanisms that are based on certain principles of insurance to charge a premium for the risk borne. Construction industry can be considered as the least developed when it comes to application of formal approaches to the pricing of risks. The price of risk in construction projects is often called contingency. More often than not, this allowance is apportioned by using lump sums and flat percentages of the direct cost that is not based on any rigorous risk appraisal. The construction industry lags behind these two other industries in their sophistication and application of risk formal risk modelling techniques.

7. Conclusions

Risk management systems are not new; many sectors including financial services organisations, insurance firms, and construction organisations, have applied them over the past 40 years. Developers use a risk premium when evaluating investment returns to reflect the level of risk they perceive in a project. Risk has become a more topical issue after events of 9/11 in the USA, and the current energy and security situation in the world. Risk assessment is a well developed area of application in the field of economics and finance, which appears to be the most sophisticated users of rational risk analysis models. The insurance industry has formalised approaches to risk assessment. However, practitioners of the insurance sector are not as sophisticated in the use of risk models as compared to their counterparts in the financial sector. The construction sector is the least developed when it comes to the application of formal risk pricing techniques. The unique nature of the construction industry and its products may be argued to justify this situation. However, construction industry practitioners can certainly benefit from the way their counterparts in the insurance and finance sectors approach risk. Thus, risk pricing practices of practitioners in the finance and insurance sectors can be used to formulate strategies and mechanisms to enhance the capacity of construction practitioners for coping with the everyday risks in construction.

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