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WEATHER DERIVATIVES AS A RISK MANAGEMENT TOOL FOR CONSTRUCTION PROJECTS

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Abstract: With the increasing complexity of construction projects, the possibility for significant delays being encountered is becoming more and more frequent. When the completion of a construction project is delayed, the result is added expenses for both owner and contractor. Although there are a variety of causes for construction project late delivery, certainly the most common cause is abnormal weather such as excessive precipitation, extreme cold or extreme heat, and other atypical weather. Although it is known that using hedging as a risk management tool adds value to a financial firm, limited knowledge has been established about using weather hedging in the construction industry. The first objective of this research is to compare weather hedging contracts with regular insurance policies. The second objective is to develop a step-by-step guideline for applying weather hedging in the construction industry. The guideline presented by this research helps construction companies to reduce the risk of late project delivery due to extreme weather. The research outcomes indicate that weather hedging have many advantages over regular insurance policies. Further, the research concludes that applying weather hedging in the construction industry could reduce the cost of construction projects and should not be overlooked by construction companies.

1 INTRODUCTION

Unexpected weather change is one of the top reasons for construction projects to fall behind schedule. Weather risks are defined as the uncertainty in cash flows and earnings caused by non-catastrophic weather events such as temperature, humidity, rainfall, snowfall, stream flow, and wind (Brocket et al. 2005). This risk affects almost all businesses. As estimated by the Chicago Mercantile Exchange (CME 2009), one-third of businesses worldwide are directly affected by weather conditions. Therefore, weather derivatives are appealing to many companies, because of the negative correlation of costs and revenue different companies can have for the same weather condition. The purpose of weather derivatives is to allow companies to insure themselves against fluctuations in the weather. Although it is known that using derivatives as a risk management tool adds value to a firm (Marsden and Prevost 2005), the weather derivative is a relatively new concept for construction-related companies.

Construction contracts are often designed with incentive clauses, often based on the date of completion. If the construction company finishes ahead of time, they are rewarded a predetermined amount per day. Conversely, if the project is finished after the deadline, the construction company pays a predetermined penalty per day. Adverse weather is one of the most common reasons for missed deadlines, making weather derivatives highly relevant for construction companies (Banks 2002). Contractors are often given a normalized number of days by which it can exceed its deadline due to adverse weather. In cases where such normalization days are not granted, the contractor can buy weather derivatives to cover any penalties that may occur, and build the derivative premium into the cost of the bid. Hedges for the construction industry are usually based on adverse construction days (ACDs) over the planned construction period. The underlying in such contracts can be rainfall / snowfall in excess of predetermined daily amount, temperature above / below a predetermined daily level, or a combination of the two. As contractors are highly aware of incentive amounts attached to the construction contract, ACD-hedges are often constructed to replicate the profitability of a construction contract.

2 LITERATURE SEARCH

2.1 Hedging

A hedge is an investment position projected to offset potential losses that may be incurred by a companion investment. Derivatives in general are hedging tools, and they can be defined as contracts whose value is derived from one or more variables called underlying assets (i.e., weather). Both forward and future contracts are an arrangement to buy or sell something at a future date at a fix price. Contrasting forward contracts, futures contracts trade on central exchanges, called future markets (Morrell and Swan 2006).

Another type of derivative is called an option. Options are of two types: calls and puts. Options give the buyer the right, but not the obligation, to buy or sell a certain quantity of the underlying asset, at an agreed price on or before a certain future date (Morrell and Swan 2006). The last type of derivative is called a swap. Swaps are private arrangements to exchange cash flows in the future according to an agreed formula (Mattus 2005). Companies choose the hedging tool according to their own needs and plans. The formerly mentioned derivatives utilize different time periods. Some consist of a shorter hedging period, and some consist of a longer time period, as suggested by Long (2000) and noted in Figure 1.

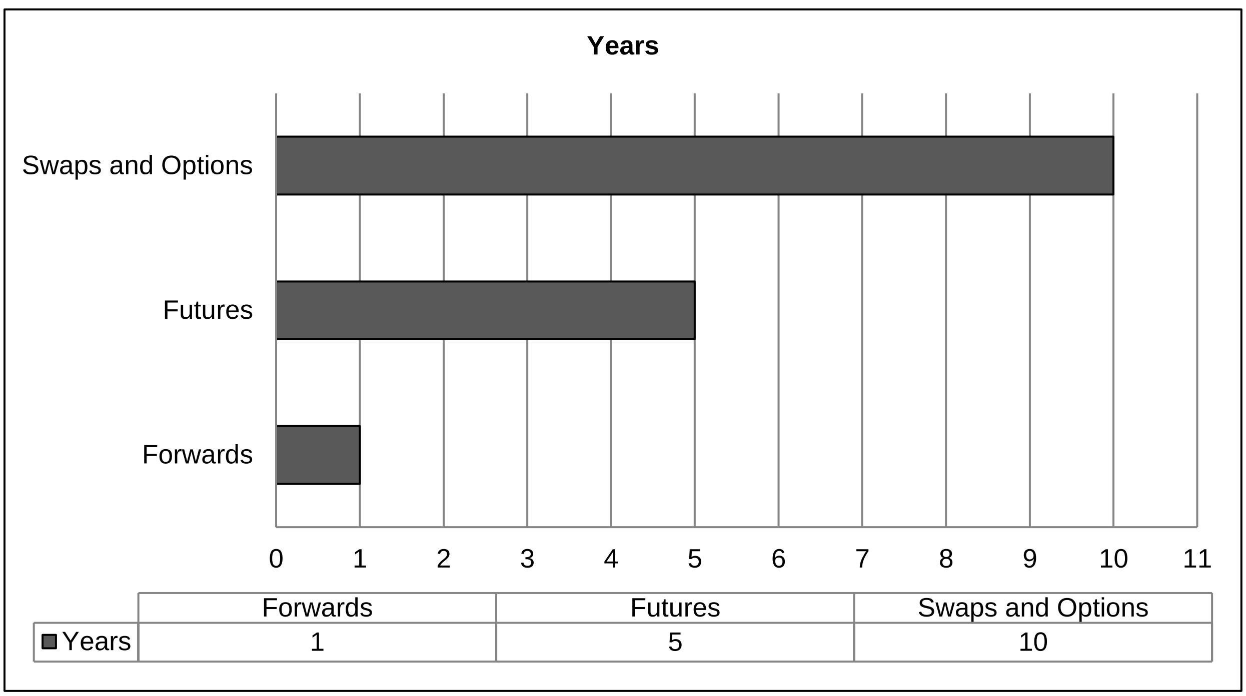

Figure 1: Derivatives contracts trading horizons

2.2 History of Weather Derivatives

A financial weather contract (weather derivative) is a weather contingent contract whose payoff is determined by future weather events. The contract links payments to a weather index that is the collection of weather variables measured at a stated location during an explicit period. Underlying assets of weather derivative are most often air temperature, rainfall, wind speed, and so forth (Riker 2014).

The history of weather derivatives started in the United States, where the first publicized weather contract between two parties, Koch Energy and Enron, took place in 1997. That contract was based on a temperature index for Milwaukee, Wisconsin for the winter 1997-1998. There are many ways to trade weather derivative. Primary market trades are usually Over-The-Counter (OTC), meaning that they are traded directly between the construction companies and banks (Jewson and Brix 2010). After several years of OTC trading in weather derivatives, the Chicago Mercantile Exchange (CME) took trading in weather derivatives a step further by introducing publicly traded futures and options on futures in 1999 (CME 2009).

By now, these relatively new financial instruments consist of combinations of instruments such as swaps, options and option collars (calls and puts together). The payoffs of these instruments may be linked to a variety of “underlying” weather-related variables, including heating degree days, cooling degree days, growing degree days, average temperature, maximum temperature, minimum temperature, precipitation (rainfall, snowfall), humidity and sunshine. This wide range of products offers businesses many opportunities to hedge all sorts of weather related risks. The expansion of the market was driven by a number of important events that happened in the late 1990s. One of which is the liberalization of the energy market in the United States. Prior to that, electricity companies could hedge themselves against drops in prices by buying ordinary energy derivatives. However, with the liberalization they not only needed protection against drops in prices but there was also the risk of a volumetric drop (quantities of consumption drop). That fueled the demand for a derivative that was based on an underlying variable that is directly linked to the weather (Huault and Rainelli-Weiss 2011).

There are several elements that define a weather derivative as suggested by Climetrix (2014). The first element is the reference weather station which is used as the reference location for the weather hedge. Second, is the weather index which defines the degree of weather which determines when and how payouts on the contract will happen. Third, is the term over which the underlying index is calculated. The next element is the weather derivative structure such as puts, calls, and swaps. The final element is the premium which is an amount of money that is paid by the buyer of a weather option. The premium is usually between 10% and 20% of the amount of the contract (Climetrix 2014).

2.3 Weather Derivatives in the Construction Industry

Roads, bridges, and buildings are built with inherent risks because of weather. As part of the construction process, earth must be moved and graded, roads need to be paved, or steel must be hoisted to its proper place. However, significant amounts of rain, extreme heat or cold, snow, and high winds can all delay construction, and if those weather conditions occur just before winter, the delay can last for months. In recent years, the weather derivative concept has been introduced to construction companies (Holmes 2014). Weather derivatives help construction companies avoid the losses due to a period of rain or other bad weather when construction workers cannot work outside. Construction companies may use free or paid weather prediction services to monitor the weather, but the accuracy of these services can be minimal and do little to reduce the financial impact of the weather (Holmes 2014). By using a weather derivative, construction companies can manage and mitigate the financial risk of extreme rain during construction (Riker 2014). The added value of risk management is researched extensively by Smithson and Simkins (2005), they found that using risk management tools was indeed associated with a reduced risk for both financial and non-financial companies. This research aims to develop a step-by-step guideline to utilize weather derivatives as a risk management tool in the construction industry.

3 METHODOLOGY

First, this research conducted a literature review to compare weather derivatives contracts with regular insurance policies. Second, this research conducted a detailed investigation of how the airlines have conducted hedging for fuel costs. This research identified best practices in the area of airline fuel hedging, and discussed how these best practices can be applied to the construction industry. Also, this research collected knowledge on the application of weather hedging in the construction industry and used this knowledge to create a step-by-step guideline to applying weather hedging successfully.

The “best practice” refers to a way that has constantly shown results superior to those achieved with other means, and that is used as a benchmark (Stevenson 1996). To identify best practices in the area of airline weather hedging, this paper considered two criteria. The first regards quantitative criteria. In this criteria, the paper looked for the hedging practice that consistently shows the pursued results. This means that the practice has been used for a long time, and each time the practice has been used it gave the same result. Between many of the articles that this research considered, eight primary research articles identified the same hedging practices as the best practice in airlines industry. The second criteria regards the qualitative aspect. In this criteria, this research looked for the practice that has a direct or immediate effect on the results. This means that the practice has a direct relationship with the result. Three research articles has been identified to meet the qualitative criteria. The hedging practice should meet both criteria to consider it as a best practice as noted in Figure 2.

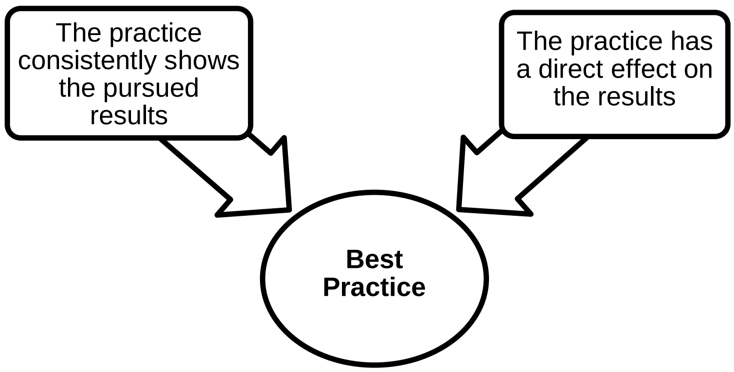

Figure 2: Criteria to select best hedging practices

4 WEATHER DERIVATIVES VS. INSURANCE

Unlike regular insurance, where there is a need to file a claim in case of any damage, derivatives give a pay-out regardless of any damage that might have occurred to the holder of the derivative. As a regular insurance contract pays off only in case a claim is filed, a derivative generates payoffs irrespective of the eventual damage (Glaube and Collins 2002).

Insurance contracts are usually designed to generate payoff in case of extreme weather conditions. Insurance contracts that protect construction companies in case of severe weather conditions are not common. Therefore this market is not competitive and premiums are likely to be high (Groningen 2012).

Another difference between the two products is that a weather derivative can be traded at any point in time. In case a construction company takes on a new project, it can easily buy or sell derivatives based on the new exposure. For insurance firms this process is far less easy and more costly (Glaube and Collins 2002).

Unlike insurance, weather derivatives are used by speculators. This implies that weather derivatives can potentially be very volatile. A risk manager working for a construction company should avoid having a speculative position because it might endanger the companies’ solvability (Stulz 2003). Therefore the focus should solely be on hedging the exposure, and not exploring weather contracts.

As a result of all derivative contracts being standardized, transparency on this liquid market is high. This is the opposite for insurance policies. Because of the highly client specific details it is hard to compare two individual insurance policies. The actual monthly or quarterly premium that is due each period is dependent on many factors. For instance: coverage, excess and primary and secondary preconditions. This makes it hard to compare insurance policies with one another. Table 1 shows the differences between insurance and weather derivatives as suggested by Huault and Rainelli-Weiss (2011).

Table 1: Differences between insurance and weather derivatives

	Insurance	Derivatives market
Objective	• Protection against risk	• Protection against risk • Exploitation of new financial opportunities • Speculation
Nature of the product	• Tailored contracts • Costs occur irrespective of the weather conditions • Need of failing a claim in case of any damage. Damage needs to be directly related to the weather conditions • Relative large risk premium	• Standardized contracts that are publicly traded • Contracts value is volatile • Can be purchased without actual exposure to the market variables that impose the risk • Like other derivatives, weather derivatives can be bought freely to diversify portfolios • Extensive knowledge of the products is required.

All in all, it is safe to say that weather hedging has many advantages over regular insurance policies. The next section will provide construction companies with a guideline to apply weather hedging.

5 GUIDELINE TO APPLY WEATHER HEDGING IN THE CONSTRUCTION INDUSTRY

This section provides construction companies with a step-by-step guideline to apply weather hedging successfully. These steps are: define the type of weather that affects the project, estimate the penalties for delays because of weather, compare hedging cost vs. penalties for project delays, identify the reference weather station location, identify the strike value, identify the tick value, identify the maximum payment, and choose the weather risk contract type.

5.1 Define the Type of Weather That Affects the Project

This is related directly to the project location and the month or the season of the year. For example, if the project is located in a hot area or a desert, the construction company will be interested in buying a weather hedging contract to cover themselves in case of project delay because of high temperature. On the other hand, if the project is located in a cold area, the construction company will be interested in buying a weather hedging contract to cover themselves in case of project delay because of low temperature.

5.2 Estimate the Cost of Delays Because of Weather

When a project is delayed because of the weather, contractors will often incur additional overhead costs and may lose the opportunity to engage other work because their forces are still held up on the delayed project. Sometime, the construction company pays a predetermined penalty per each day after the project deadline. The overhead cost, the opportunity cost and any penalties should be used as a reference point to decide if the cost of buying a hedge contract is worth it.

5.3 Compare Hedging Cost vs. Cost of Project Delays

Before buying a weather heading contract, construction companies should analyze the cost of the contract. For example, the company should compare the contract cost with the delay costs (i.e., overhead cost and opportunity cost).

5.4 Identify the Reference Weather Station Location

Construction companies have to determine which weather station has the highest correlation with the temperatures on the construction site. This is important because choosing the best weather station location will increase the accuracy of weather forecast and therefore the accuracy of the hedging contract.

5.5 Identify the Strike Value

The strike value is the point where project delays become intolerable. The construction company should choose this points as the activation point for the hedging contract (at this point the contract will start to pay off).

5.6 Identify the Tick Value

The tick value is the gradual payment increase for each increment of temperature increase or decrease (it could be precipitation in case of rain).

5.7 Identify the Maximum Payment

The maximum payment of the hedging contract should be equal to the maximum cost of delays because of weather.

5.8 Choose the Weather Risk Contract Type

The pay-out structure of a temperature related weather derivative is in 90 percent of the cases (Crouhy et al. 2006) based on the following three constructs:

1. Heating Degree Days (HDD)
2. Cooling Degree Days (CDD)
3. Cumulative Average Temperature (CAT)

HDD and CDD futures are contracts that measure how much days per contract period, which is either a month or a season, a day's average temperature deviates from 65 degree Fahrenheit (or 18.33 Celsius). The HDD season is from November until May. This period is called the Heating Degree Day season because historically, the utility industry used 65 F as the base-line temperature at which the furnace would be switched on (Cao et al. 2003). A CDD contract is the measure for the number of Cooling Degree Days, which indicates the number of days per contract period on which electricity consumption is likely to increase due to the warm weather. A CDD season is from May until September. The remaining months April and October are often referred to as shoulder months. Contracts based on the Cumulative Average Temperature index are used for the summer season. Unlike the CDD or HDD index there is no baseline of

65 degree Fahrenheit. It is simply the average daily temperature over a calendar month. That average is used to calculate the contract value (Groningen 2012). The following is an example of a weather hedging contract for a construction industry:

Coverage Period: From November 1 to May 31

Weather Contract Type: HDD

Strike Value: 65 F

Tick Value: $100,000 per 5 F

Maximum Payment: $1000,000

In this example, the contract seller would pay the construction company $100,000 for each 5 degree Fahrenheit in excess of 65 degree Fahrenheit, up to a maximum payment of $1000,000. If the temperature reaches 100 degree Fahrenheit, the construction company would receive $700,000 from the contract seller (Holmes 2014). Figure 3 illustrates the weather hedging steps as a flowchart.

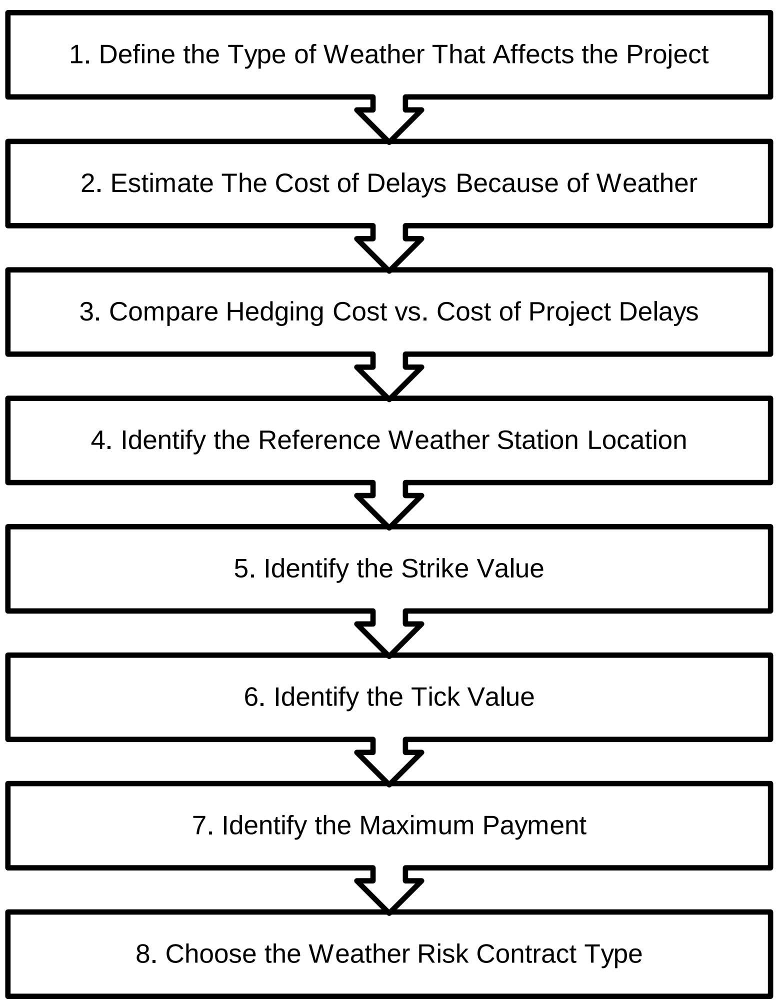

Figure 3: The weather hedging process steps

6 RESULT

The research conducted a literature review to compare weather derivatives contracts with regular insurance policies and presented a step-by-step guideline to apply weather hedging in the construction industry. The research concludes that applying weather hedging in the construction industry could be very useful and should not be overlooked by construction companies. The guideline presented by this research helps construction companies to apply hedging to mitigate the risk of project delay due to extreme weather.

The next logical step in the development of this construction weather hedging guideline is to test the validity of the extended model developed in this research. This could be done by taking completed projects, with their original cost estimates and their actual costs, then consider if a weather hedging contract has been applied what would have been the effect on the actual cost of the projects.

Future work in this area could include investigation of weather hedging cost to decide if the hedging application is economically feasible. This is could be added to step three of the model. Similarly, further investigation on the best way to settle the hedging contract is recommended. This could be done by simulating different scenarios of hedging situation. This would generate different settlement options for consideration, such as moving out from the hedge early or keep the hedge contract until its due date.

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