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THESIS

Summary

WEATHER DERIVATIVES - PRODUCT OF THE INSURANCE AND STOCK MARKET CONVERGENCE

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” Everyone talks about the weather, but no one does anything about it.”

Mark Twain

Thesis content

Key words

Burn analysis, Chicago Mercantile Exchange, Cooling degree days, exotic options, Heating degree days, Index based insurance, Weather derivatives, Weather index.

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Summary content

Introduction

The selected area of interest and the issue of this thesis is "Weather derivatives - product of the insurance and stock market convergence", and it is a promising field. This opinion is justified by the fact that weather derivatives are a alternative risk transfer technique and by the fact that in recent years weather derivatives are considered an innovative form of insuring investments.

This paper aims to establish the weather derivatives foundations, based on the study of historical milestones in the development, valuation and price determination and then draw up a model for a contract and exemplify the advantages of using these financial and insurance product in our country.

Weather derivatives are a way of protecting against the negative financial impact of unexpected weather events, others than those covered by traditional insurance policies.

The materialized risk in this case is weather risk. Weather risk measures the magnitude of expected outcomes of the deviations from normal weather within a predefined time interval (week, month, season, etc.). The specific features of weather risk are: precise location, impossibility to control the forecast, unreliable forecasting despite technical advances.

On the European continent, the weather derivative market has a significantly slower development than the one in the USA. Causes for this slow development are:

a) lack of reliable weather information, accessible under standard or financial form,
b) there is less temperature variation in the European countries than in the USA,
c) the fact that the European energy markets are behind the USA in terms of de-monopolization and privatization.

Contracts that are influenced primarily by weather temperature or weather conditions are little known in Europe. The first energy markets that have been opened to these contracts were the British and the Scandinavian ones, where rainfall rather than temperature is a underlying variable.

Interested in the use of weather derivatives as investment and protection are:

a) Companies whose earnings are exposed to temperature variations as: temperature, rainfall, wind, speed, etc. For example: farms, gas or electricity distributors, tourism and entertainment (theme parks, outdoor events, etc.),

b) Insurance and reinsurance companies issuing weather derivatives,
c) Investment and commercial banks, which use weather derivatives as a means of investment for financial protection, similar to interest rate and currency risk hedging,
d) Hedge funds and investors, that see weather derivatives a risk broadening instrument.

The main objective of this thesis is the study and analysis of ground conditions for the use of weather derivatives in Romania. The specific objectives of the present thesis are presenting the weather derivatives and the weather market, detailing the structure of the contracts, explaining the modeling and valuation processes of weather derivatives.

The motivation for choosing this PhD thesis is the desire to identify a financial product that has the property to protect the members of the economy from losses caused by sudden weather changes, as the ones taking place in recent years. Weather derivatives are innovative products whose applicability is triggers when traditional insurance contracts cannot provide protection any more.

During the elaboration of the thesis, as required methodologically, a variety of research methods were used to achieve the objectives. For starters we used induction and deduction. These qualitative analysis helped us identify issues relating to the structuring and need for weather derivatives (Chapter 1,2,3). Another qualitative technique used is the comparative analysis, which helped us to formulate the structure of the modeling and valuation aspects (Chapter 4). To increase the scientific relevance of the thesis and support the theoretical hypothesis of the thesis, we analyzed the available data by means of the Eviews 7 program , so that we could formulate some final conclusions concerning the usefulness of weather derivatives in Romania (Chapter 5).

The thesis is divided into five chapters that follow a desired logical structure, based on the theory framework and empirical research of weather derivatives, and continuing with demonstrating the applicability of the theoretical aspects. Thus, a number of questions are raised: *What are weather derivatives? Which is their market? Which is the structure of these contracts? How do you determine the price of these contracts?* and as for the study: *Would weather derivatives be of interest? How would a contract look like?*

Now we shall conduct a brief presentation of the structure of the thesis:

The first chapter called **” Introduction in the world of weather derivatives”** wants to set the fundamentals of weather derivatives, conceptual approaches and a comparative analysis of weather derivatives, traditional insurance contracts and index based insurances. This approach highlights the basic risks covered by weather derivatives.

The second chapter, **” Weather derivatives market - players and institutional framework”**, presents theoretically the members of the weather derivatives market, dividing them into end-users, brokers and presents the stock markets that sell weather derivatives. In this chapter you will also find a presentation of the tax and accounting perspective on weather derivatives, since they can be treated as insurance or financial product.

The third chapter, entitles **” Structural elements of weather derivatives”,** is aimed to present the key components of weather derivatives. It addresses the six structural parameters indispensable for structuring such a contract, and then illustrates the financial contractual forms weather derivative can take.

Chapter four,**” Modeling and valuation of the price of weather derivatives”** provides a review of models and methods for pricing weather derivatives and presents aspects of temperature modeling. In this chapter we find descriptions for the Burn analysis, the reasons why the Black-Scholes model does not apply to weather derivatives, etc. The chapter ends with an tabular analysis of the advantages and disadvantages of the most commonly used weather derivative valuation models.

The last chapter, ” **A case study of weather derivatives applicability in Romania - the example of Compania de Apă Someș S.A.**”, is a novelty brought to the research, because of the study of temperature indices, in their HDD and CDD form for Romania and then continuing with a study of the correlation of temperature and water consumption for Cluj-Napoca, between January 2007- December 2012. This chapter includes an example of a weather derivative structure adapted to Cluj-Napoca's drinking water supplier, Compania de Apă Someș SA.

At the end of this scientific endeavor we find the conclusions of the research, limitations and prospects for future research.

It is of taking into account that the current thesis is a starting point in the study of complex and interesting subjects, such as weather derivatives.

Synthesis of Chapter 1. Introduction in the world of weather derivatives

Weather events affect all areas of the economy. It is estimated that the economy, in particular weather dependable sectors (such as agriculture, construction, energy production, etc.) reach a considerable amount of the GDP, for example they reached 10% of the US GDP[1].In order to reduce risks associated with unexpected weather and climate phenomena, many companies have started to make weather derivatives a part of their risk management strategies. The most often used techniques are based on: Heating Degree Days (HDD), Cooling Degree Days (CDD) and Cumulative Average temperature (CAT).

The forecasts that weather derivatives are based on are the mappings of the seasonal estimates. Forecast abnormalities for the value of weather derivatives are in general correlated to the registered charting errors[2]. However, an adjustment of the differences between the recorded local temperatures and forecasts made by the National Weather Agency are always required.

When we talk about weather derivatives we should have in mind that the concept should be studied both from the conceptual perspective and from the view of the valuation of such a contract.

Table 1 summarizes the personal contributions of the most influential authors in the field of weather derivatives.

Table 1 Summary of weather derivatives approach in the scientific literature.

Authors	Year	Personal work	Area
Lixin Zeng	2000	Addresses concepts related to defining weather derivatives and explain the valuation procedures.	Valuation
Geoffrey Considine	2001	Illustrated the mechanisms and conditions for the first weather derivative traded contract on the OTC market.	Concepts
Alan Jung and Cyrus Ramezani	2001	Reviews the insurance and reinsurance activities that include derivatives contracts.	Concepts
Helyette Geman	2001	Addresses weather derivatives as financial products of an exotic nature. Their exoticism comes from the fact that these derivatives show a link between the weather records and the premium paid by the insured.	Concepts
Michael Moreno	2001	Determines the cost of providing additional electricity in the	Valuation

[1] Procentaje for 2004, PriceWaterhouseCoopers, WRMA Survey 2004-2005.
[2] Ciumaș, C., Botoș, H.,2011, *Weather Index-The basis of weather derivatives*, The Journal of the Faculty of Economics, Oradea.

		event of a extreme climate event, and how weather derivative can cover it.	
Pauline Barrieu	2002	Exposes the correlation between weather derivatives and weather phenomena. The author considers that the econometrical assessment and the simulation can be useful in determining the hypotheses of the optimal weather derivative.	Valuation
Andrea Stoppa and Ulrich Hess	2003	Shows how to use and build weather derivatives for agriculture..	Concepts
Peter Alaton	2004	Determines models for calculating weather derivatives price, based on the premium paid because of the indices evolution.	Valuation
G. Considine	2005	Analyzes the historical reasons that led to the need for weather derivatives and their advantages.	Concepts
Mark Tawney	2005	Defines the concept of risk management and weather markets for these derivatives.	Concepts
Stephen Jewson and Anders Brix	2005	Explains concepts related to weather derivatives valuation and pricing, either individual or as part of a portfolio.	Valuation

Source: author

A standard weather derivatives contract covers the following aspects:

1. contract period: the start and completion date,
2. reference weather station: location,
3. weather variable underlying the contract, measured by the reference weather station ,
4. indices that structure the analysis of the meteorological variable during the contract,
5. contract execution value, thus allowing the conversion of the index into a financial value,
6. the premium paid at the beginning of the contract.

The risks faced by enterprises in terms of weather are somewhat unique. Weather tends to affect the output and demand faster than price. An exceptionally warm winter, for example, can leave energy and gas supply companies with an excess (the population needs less heat). A cold summer can leave hotels and airlines seats vacant. While price levels may fluctuate as a result of the increase and decrease in demand, price adjustments cannot compensate for unexpected weather developments.

The main sectors interested in the coverage offered by weather derivatives and the risks against which they protect can be found in table 2.

Table 2. Examples of potential weather hazards covered by weather derivatives

Sector	**Weather risks covered or that may affect the sector**
Energy	Reduction or increase in energy demand.
Hedge funds	Hedge of income from weather sensitive businesses.
Agriculture	Harvest delays, storage problems or pest attack caused by weather changes.
Insurance	Differentiation of premium depending on the frequency and intensity of

	weather events.
Entertainment	Delays of events or reduction the number of participants..
Sales	Reduction of the demand for weather sensitive products.
Constructions	Delays and enforcement of penalty clauses when contract are not respected.
Manufactures	Demand reduction or rising costs of raw materials.
Transports	Delays, cost and budget overrun.
Manufacturers	Decrease in demand, increase in costs of raw materials.
Government	Expenditure overruns.

Source: Charles Piszczor, Paul Peterson, Research & Product Developement, CME Group, The Weather Derivatives Markets at CME Group: A Brief History, 28.09.2011.

The potential advantages brought by weather risk management methods are: reducing earnings volatility, bankruptcy prevention, domestic financing solutions, etc.

Weather has always been the biggest risk for sectors as agriculture, affecting all aspects of development. In developed economies there is a significant share of sectors where the activity is based on agriculture, thus weather risks remains one of the main threats of the economy. Crop variety, production techniques and agricultural management practices are factors that can minimize risk, however, farmer will always be affected by uncontrollable factors such as weather related events that can have a significant negative impact on the quality and quantity produced[3].

In response to these problems and to encourage the development of international weather risk markets (existing in USA, EU and Asia), the World Bank's Commodity risk Management Group (CRMG) has started a project to develop weather index-based insurance contracts. The weather index based contracts cannot replace traditional insurance policies or other means of risk protection. such as the use of innovative technologies, diversification of crops, making savings, etc. but the give farmers a way to complement their protection.

Traditional insurances are based on the principle of the compensation arrangement, where losses are measured in terms of the affected area or from the perspective taken of harvest returns. These products, although appropriate in some contexts, have limited coverage for both insurer and insured. From the perspective of the insurer, the farmer will always have more information about the risk in the business and agricultural risk management practices then the insurer, thus creating an asymmetry of information available between them. The farmers behavior and activities may affect the probability of the loss or the volume.

[3] Ciumaș, C., Botoș, H.M., Chiș,D.M., 2012, *Insurance contracts based on indices, a step towards weather derivatives*, EINCO 2012

Weather indices based insurance contracts work differently than traditional insurance. Index based contracts can be used only if the risks have a spatial correlation, such as droughts. They are applicable to idiosyncratic risks such as pests or hail, which can affect only one farmers crop. Premiums are not paid based on performance deficits registered by a farm, but according to index deficit correlation to factors that can be used to estimate losses. These indices, based mostly on weather data, are the base for insurance contracts and are used to determine when compensation is required on the basis of the contract parameters. The advantage of these index based contracts is that they are built on available and verifiable information, such as rainfall, which has a substantial and long historical record, which allows a more accurate valuation. Because indexes are determined objectively, many traditional security issues such as moral hazard and adverse selection are removed.

The design stages of an index based insurance contract are:

a) designing the insurance product,
b) planning and implementation of the use of the index insurance product,
c) determining the conditions due for market growth.

The key elements of market growth are considered to be:

a) infrastructure for conducting meteorological observations and data collection,
b) determine the technical feasibility of the product,
c) determine the customers and their integration in the chain of activities,
d) ownership,
e) legal framework.

This segment was aimed to present the key elements of sustainable investment performance and effective weather risk management programs through weather indices, respectively index based insurances in developing countries.

The intended purpose of chapter 1 is to summarize the existing knowledge and provide some directions to address the market investments. New players emerging in this community, that aim to developed index based contracts will help improve and refine the sector, future application will expand the understanding of risk management and the way weather will be used to promote economic development.

Synthesis of Chapter 2. Weather derivatives market - players and institutional framework

In the literature there can be found a variety of papers dealing with the structure of weather derivative or the differences between weather derivatives and traditional insurance contracts. The purpose of this part of the thesis is to study the members and users of the weather derivatives market. Market presence can be classified as end-user or intermediaries-investors.

The end users are the ones behind the demand and they are the beneficiaries of weather derivative. These are: the energy sector, agriculture, tourism, food industry, municipalities and constructions.

On the other side , the partners have a more homogeneous structure. Energy companies, banks and insurance companies have acquired the skills and have made the necessary structures in order to use such contracts. They are the key players that buy the risk.

The market stakeholders operate on the financial markets, whether exchange traded or on the OTC markets.

In the beginnings the transactions of the OTC market and client-broker relationships weren't very spectacular. This is due to the nature of the markets, client-broker relationship is based on confidence, meetings are held behind closed doors and discussed figures are rarely made public. However, market development was helped by sector and contract evolution.

The markets that weather derivatives are traded on are the Chicago Mercantile Exchange and Euronext.Liffe.

The Chicago Mercantile Exchange is the largest US market for goods and the second Future market worldwide. CME brings together buyers and sellers for both "open out-cry" and Globex platform, trading platform online 23h/5 days a week. Since September 1999, CME has traded future and European type option contracts of for average monthly indices of daily heating levels.

Euronext is the result of the merge of the Amsterdam, Brussels and Paris stock and commodities exchanges in September 2000. Liffe (London International Financial Futures and Option Exchange) joined later this structure, the new structure taking the Euronext.Liffe name, and becoming a WRMA member. In December 2001 the exchange traded the first series of weather contracts for 3 European cities. The contract were based on the monthly average of daily average temperatures for Berlin, London and Paris.

Synthesis of Chapter 3. Structural elements of weather derivatives

Describing the products and the their application in the weather market is the goal of the next chapter. It explains the basic elements of weather derivatives and then focuses on the different derivatives types. The latter is divided into four subdivisions: options, swaps and futures (classified in the same category), collars and exotic contracts.

Parameters of weather derivatives can be divided into two parts: basic elements and the chosen security type. Some of the basic elements are:

1. **Underlying indices** - the payment is depending on them, eg: HDD or CDD indices.
2. **Weather station -** location for meteorological data collection .
3. **Accumulation period** defines the period for which the indices are calculated , this can be at a week, a month or a season (eg. 1 november-31 march or 1mai- 30 september).
4. **Pay-off structure** - is based on pay off that serves the contract. As mentioned above they can be options, swaps, futures, etc.

As with any derivative, its value depends on the underlying asset. While standard products depend on stock price, the price of coffee, oil prices or interest rates, weather derivatives have as underlying asset weather events. Choosing the appropriate index of such a contract is crucial for determining further hedging strategies. Weather wise it is recommended to choose the best protection for the exposure wished to be covered. Thus the most frequent underlying index are temperature, precipitations or wind.

As expected, the most common underlying asset is the temperature. This is because the demand for heat from the energy sector in winter , the companies are trying thus to find the best methods to protect against unexpected weather events, given the high correlation between the location weather data and long-term temperature records found in national meteorological databases. Temperature can be incorporated into two indices: the degree day index and the average temperature index.

The degree day index is an index preferred by the energy sector, that they have been using for a long time. Because the US market is focused more on energy companies, unlike the diversified European market, the degree day index has become the most widely used index. It has two main forms: the Heating Degree Day index (HDD) and the Cooling degree Day (CDD) index.

The average temperature index (Y_i^{av}) is calculated as the mean of the maximum and minimum temperature recorded daily, at 12 hours intervals. Below we have the specialized formulas for three index: Heating degree day (HDD), Cooling degree day (CDD) and Cumulative average temperature (CAT).

$$\boldsymbol{HDD = \max(18 - Y_i^{av}, 0)}$$

$$\boldsymbol{CDD = \max(Y_i^{av} - 18, 0)}$$

$$\boldsymbol{CAT = \sum Y_i^{av}}$$

In many location where the Heating degree day index is of interest, in some periods the average temperatures do not exceed 18^0C/65^0F, thus HDD value being always positive. The heating index is used in the US and Europe, but rarely in Japan. The Cooling degree index is traded predominantly in the US and rarely in Europe or Japan. The total amount of HDDs and CDDs registered in a given day is the deviation shown from the average base temperature: in one day either HDD or CDD is zero, and when both are zero the daily temperature is equal to the base temperature set as reference in the contracts, 18^0C. The CAT index are predominantly used during summer in Europe.

Synthesis of Chapter 4. Modeling and valuation of the price of weather derivatives

This chapter intends to be an introduction to the modeling and price valuation of weather derivatives. We intend to show that weather derivative are becoming ubiquitous tools of risk management. There isn't a unique solution for determining the price of weather derivatives, such as the Black-Scholes model for European options. The academics and practitioners have different approaches, some seeking practical daily use methods, while others seek determining of the fair price. A perfect solution has not yet been found, but it is possible that this question to have a rhetorical answer.

The hedging of unexpected weather events is an important decision. With weather events, the arising question is whether it is possible to diversify the economical activities in order to cover a broaden geographical area. To highlight this fact, academics have studied the correlation between temperature locations, studies have been made with-in and between countries. The results were surprising showing that geographical risk diversification is almost impossible to do, thus the risk diversification of a portfolio is impossible, specially for events as rain.

In order to have a complete outlook on temperature, you have to take into account the following: warming trends, seasonal evolution, weather heteroscedasticity and temperature autocorrelations.

At the basis of derivative pricing we have the derivative valuation, that involves determining the value at a certain moment or a time before the contractual maturity, given that they will generate a gain for the buyer. This assessment can be extremely useful in order to exercise control and risk management needs faced by a weather derivatives user.

The expected profits depend upon the underlying asset. For weather derivatives an important choice is determining the asset that generates the closest values to what really takes place.

In the literature we meet a variety of pricing models, but because there is no generally accepted and applied model, users find it difficult to determine the optimal trading price.

In the following table we aim to highlight the most frequently encountered models in use, presenting their advantages and disadvantages.

Table 3 . Summary of advantages and disadvantages of the most commonly used weather derivatives pricing models

Model	**Advantage/Disadvantage**
Black-Scholes	It is impossible to use because weather data does not meet the requirements in order for the model to be successful.
Burn Analysis	The pricing model is used only for single contracts. Its susceptible to errors due to the nature of weather date.
Monte Carlo Simulation	It's a flexible model, with high precision and transparence..
The equilibrium framework model	Used regardless of maturity and duration, use a single estimation.
The incomplete market approach model	Divides the contracts into two categories, those that cover the risk and those that can't cover the risk.
Indifference Pricing Approach	It uses risk reduction methods and depends on the economic need. Pricing take place envisioning the utility of the contracts
Arbitrage pricing model	It's use is difficult due to the taking into account of the specification of the weather indices.
Financial equilibrium model	It is considered the best approach for pricing, due to it being based on the risk evaluation of the underlying asset..

Source: Bali, S, 2012, *Weather Derivatives and Pricing Approaches*; - Jewson, S., Brix, A., 2005,*Weather Derivatives Valuation- The Meteorological, Statistical, Financial and Mathematical Foundations* , Cambridge University Press; etc.

Synthesis of Chapter 5. A case study of weather derivatives applicability in Romania - the example of Compania de Apă Someș S.A.

In this chapter we will illustrate the specification of a weather derivative, the underling contract being an option. The chosen underlying asset is temperature. The structure takes after the model put forward by the Chicago Mercantile Exchange, this being their first trader.

At the present moment weather derivatives are not traded in our country, but the purpose of this paper is to lay the foundations for their future use. At this time in Romania the only exotic type contract announced are the energy derivatives.

CME contract specification are as follows:

Weather underlying event	Temperature.
Pricing unit	Euro (€) per index point*
Tick size	1 unit
Contract size	Min. 20 €
Daily price limits	n/a
Trading hours	Monday-Friday : 9,15-17,30**
Trading	OTC or on stock exchange
Last trade date	Fifth Exchange business day after the end of the contract, 9am[4]
Contract months	HDD: Oct, Nov, Dec, Jan, Feb, Mar, Apr. CDD: May, Jun, Jul, Aug, Sept.
Strike	Multiple of 1 unit
Settlement	Subject to CME regulations
Position value	Subject to CME regulations
Position limits	Subject to CME regulations
Ticker Symbol	Location code
Rules	Subject to CME regulations
Other information's	The contract are subject to CME regulations, but they can be adjusted to geographical and economical particularities

* In the UK the values id expressed in GBP(£)

** Normal trading hours 9,15-17,30, automatic trading online between 17,30-23,15.

Climate affects the revenues, profits and the performance of companies. Therefore, weather risk management becomes very important, especially in sectors such as energy; the unavailability of the data made a study in the sector impossible. For the sector of utilities, we decided to analyze water consumption. The existence of a significant correlation between

[4] Chicago Mercantile Exchange http://www.cmegroup.com/market-regulation/rulebook/

temperature and water used indicates that these companies may turn to weather derivatives (temperature being the underlying asset) to protect their incomes.

The period taken under study is 1 january 2007 - 31 december 2012. The temperature data were extracted from sources provided by Weather Underground (www.wunderground.com), and then were screened using programs put forward by the National Climatic Data Center (NCDC). Thermal data for the period is the average value expressed in Celsius degrees. The study was performed on the data for the city of Cluj-Napoca.

The series were constructed based on data supplied by Compania de Apă Someș SA and it represents water consumption (in cubic meters) recorder in Cluj-Napoca.

The data represents the average monthly water consumption billed by the water company.

We chose to process the data by means of the Eviews 7 program and Microsoft excel. The basic idea was that a linear model resulting from the study will show a correlation between water consumption (broken down in categories) and temperature.

The data provided for the study is divided into three user categories:

- businesses
- people living in houses
- people living in apartments

The linear correlation coefficient between the consumption of water by users and temperature are presented in table 4. We observe a correlation between water consumption and temperature for businesses and inhabitants in houses, but there is no correlation between water consumption and temperature for apartment residents. This conclusion was suggested by previous analyses of the data.

Table 42. The coefficient of linear correlation between water consumption and temperature

Variables	The value of the correlation coefficient	The value of the Student test (probability)	Significance
Consumption of businesses - temperature	0,55	5,6 (0,00)	The coefficient is significantly different from zero
Consumption of apartment residents - temperature	-0,001	-0,01 (0,99)	The coefficient is not significantly different from zero
Consumption of residents in houses - temperature	0.65	7.67 (0.00)	The coefficient is significantly different from zero

Source: own processing's

Due to variations in temperature, water consumption of businesses and respectively residents of houses have a significant change; intensity of the correlation between water consumption and temperature is highest for residents in houses. The water consumption of apartment residents is not significantly influenced by temperature.

The econometric estimation of the linier model is expressed as:

Water consumption of businesses = 2794,5* Temperature - 26777,1

Water consumption of house residents= 2385,98* Temperature - 22852,34

At a increase of the temperature with 1 Celsius degree, water consumption will rise with about 2794.5 cubic meters for businesses respectively 2386 cubic meters for residents in houses.

Given the significant correlation between consumption and temperature for businesses and respectively house residents, Compania de Apa Somes SA might appeal to weather derivatives that have temperature as an underlying asset, in order to protect their incomes for these two consumer segments. The correlation level is considered being moderate.

For such a contract to be of interest to a company, it needs to cover at least the equivalent gain brought by the interest rate. For weather derivatives, pay-offs are presented if the difference between the actual value of temperature difference from the determined contract temperature agreed on at subscription. For example, two investor may be partners in a contract, one paying in the hope the temperature is over the predetermined level, while the other hopes it is under that value.

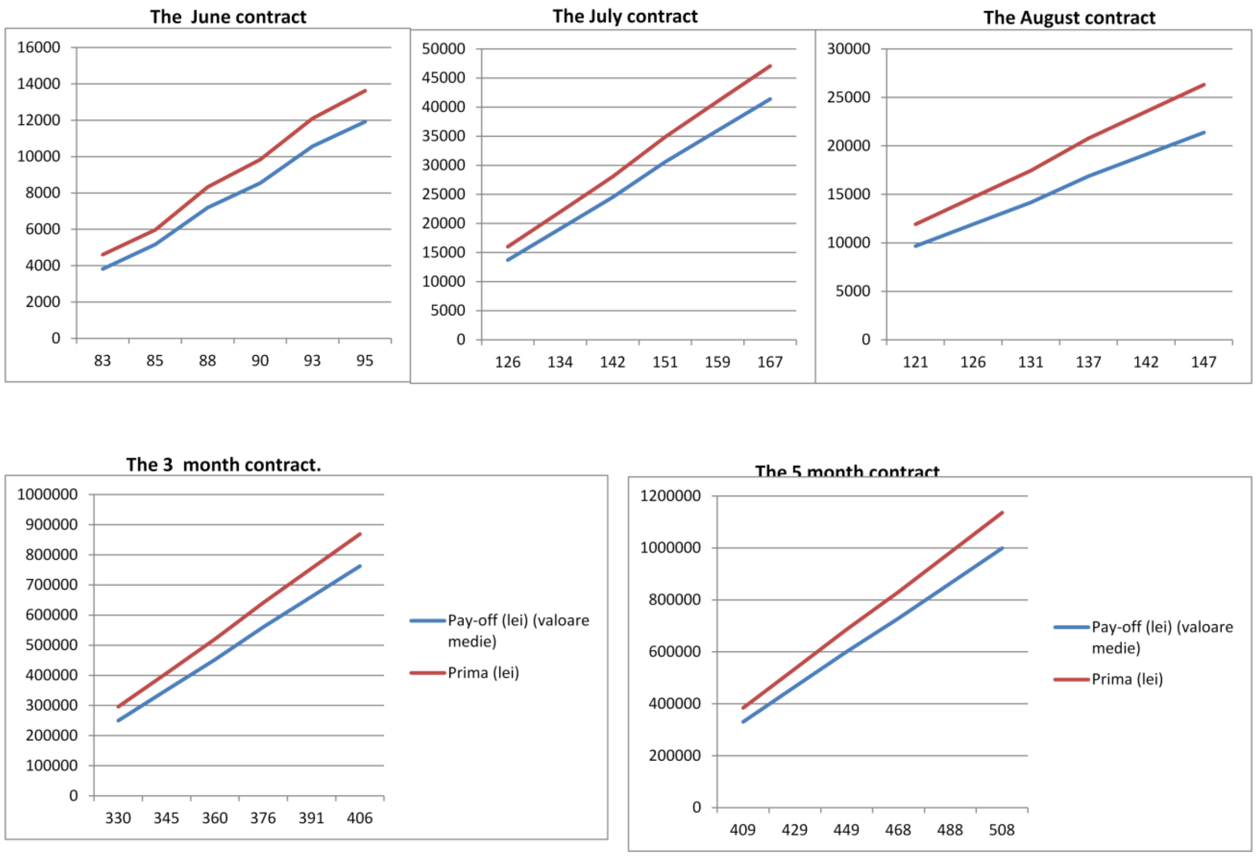
According to the contract model presented above, for the 2010-2013 period, we structured empirical monthly contracts (for June, July and August), a 3 month contract (for the June-August period), and a five month contract (period: May-September). For these contracts we computed by mean of the Burn analysis the premium and pay-off. In chart 1 we see the evolution of the premium and pay-off when the Strike level increases.

As expected , in all five hypotheses, with the increase of the Strike we have an increase in premium and pay-off.

The estimated value of the premium should be treated with caution dues to the short length of the data series available (4 years[5]). This section has as a main goal to exemplify the methodology for estimating the premium by using the Burn analysis.

[5]Historical data is recommended to cover between 10 and 30 years.

Chart 1. Evolution of the five weather derivative contracts



Source: own processing's

An improved approach consists of developing Monte-Carlo simulations for temperature based on a model developed for daily value temperature. As a result we will get an empirical distribution for the temperature based payments. From this empirical distribution we will then estimate then the premium (as an average value) and the standards deviation.

Conclusion, limitation and research perspectives

Weather derivatives are an innovative financial product that has the power to protect a company from exogenous risk that are hard to quantify. In order for them to be efficient and successful it is necessary to fully understand the functioning mechanism and the price valuation methods. This new category of instruments has a fast growing market, mainly due to the rising number of users.

In recent years companies have been looking for protection against weather events that could impact corporate earnings, with the increase of weather impact on corporate earnings.

The weather derivatives sector is particularly of interest because it provides protection against weather events by means of instruments correlated with the stock market. The limitations that make weather derivatives use difficult are primarily the lack or unavailability of appropriate statistical data. Another factor is the lack of regulation in the field that describe weather derivatives as insurance products. To be noted that traditional insurance contract cover price fluctuations, while weather derivatives cover the output.

Weather derivatives success is due to the advantages and differences brought forward to traditional insurances:

- they have a standard structure, for the exchange traded but not for the OTC,
- justifying the loss is no longer necessary,
- covers small variations of the underlying variables that can cause significant losses. (eg: temperature, wind, etc.)

The increase in demand is cause by:

- their protection of the volume of the output (eg: agriculture),
- they can be used for speculation,
- cover the negative effects of short term weather fluctuation (eg outdoor events).

The weather derivatives market is at a crucial moment in its development, the market being stable, liquid and contract valuation is not so difficult to do anymore. The lack of the transparency of pricing models combined with the lack of a generally accepted pricing methods still restricts potentials user from entering the sector. This is supported by the fact that the US dominates the energy market, thus focusing on temperature underlying contracts. Combining this with some liquidity problems, gives institutional users no access to functional counterpart, mainly due to low presence in the secondary markets, thus the supply and the demand are segmented. A solution could be the standardization of these instruments. But this could lead to a restriction of the risk management coverage, but as highlighted in the thesis, this takes place anyway for contracts when the underlying asset is temperature.

The Chicago Mercantile Exchange in this context presents the steps to be follow in order for a exchange to be successful. The market evolves when it can attract new participants. Risk managers and insurance companies find themselves drawn to this niche and its benefits. As noted in chapter 4, weather can be quantified, thus the profits and the incomes brought by the weather derivatives can be easily used to diversity risk portfolios. The demands will rise when exposure to unexpected events will increase. Rating agencies have tried supporting the market by rating risk management practices.(eg. protection against temperature fluctuations, winds, etc.)

These instruments can help risk management to face problems that are unexpected. Hedging is not always possible, but not knowing the existence of an alternative risk minimization method can make the difference between having a hard year and going bankrupt.

In the case study, we have shown that are a weather derivatives specification and the influence had by temperature on water used in Cluj-Napoca. Contracts tend to follow the CME specifications, but they are adjusted in order to comply to national regulations.

The influence on temperature on water use was research based on the data provided by Compania de Apă Somes SA.. The study reveals that between January 2007- and December 2012 there was a change is in the consumer structure. In 2007, consumers were divided as: 34.7% businesses, 44.8% residents of apartments and 20% house residents. In 2012 this changed, businesses being 26.8%(-7.9%), apartment residents 46.8(+2%) and house residents were 26.6%(+6.6%).

From the study of the linear regression we observe that apartment residents water consumption is not significantly influenced by temperature, while for businesses the influence is of 31% and for house residents is of 42%.

The premium for the case study was determined by means of the Burn analysis for Cooling degree day contracts, the premiums value following the Strike evolution. For CDDs if the Strike grows, so does the premium. For HDDs is the other way around (this is mainly caused by the index structure) .

Academically, weather derivatives present a high interest, because they show that any risk expose can be covered and modeled. If this is done through a insurance policy or a financial instrument is completely the managements decision,

Limitation were encountered, mainly because access to data was difficult. For weather data there were structural problems (if there were measurements made 3 or 4 times a day) or missing records. The statistical data the main problem was accessibility. Out study is limited to the 36 month of public data for the indexes. This short horizon, made it difficult to show the real benefits that weather derivative could have in Romania.

Despite our efforts, access to real market data was impossible, because most weather derivatives of traded OTC. The liquidity issues in the European market raise the issue that a unanimously accepted structure is hard to determine.

There are technical limitations also, weather market development is different because of the underlying asset nature, so arbitrage and hedgings are fewer in number, despite the increase in liquidity the market is still small. This is because weather does not have a fix geographical area and is a nonstandard underlying asset.

Compania de Apă Someș SA was chosen as the example for our research, but private data owned by the energy sector or agriculture could illustrate better the attractiveness of this instruments.

Future prospects include determining the weather derivatives market optimal development strategy and ways to diversify the underlying asset. Main conditions are increasing market participation and diversification of these contracts.

Based on the characteristics of the national economy, we consider appropriate the use of weather derivatives underlying temperature, precipitation and snow.

In Romania at this time weather derivatives are not traded, but the introducing of financial instruments with energy as an underlying asset by the Sibiu Stock Exchange, fulfils a prerequisite for the future use of weather derivatives in our country.

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