



February 25, 2003

Frankfurt Voice

Weather derivatives heading for sunny times

- Around four-fifths of all economic activity world-wide is directly or indirectly affected by the weather. Yet, until just a few years ago, there were no financial products that allowed an economically intelligent response. The creation of weather derivatives from the late 1990s has greatly improved the situation. However, knowledge about just how dependent different sectors really are on the weather is still very rudimentary, and this is hampering the development of the market.
- Weather derivatives are financial innovations based on data such as quantities of precipitation (rainfall, snow depth), number of days on which it rains, hours of sunshine, air temperature or wind speed. The fact that the underlyings (the weather data) are completely independent of goods or financial markets distinguishes these from other financial derivatives.
- Besides enhancing risk management, weather derivatives can be an interesting marketing instrument, allowing firms to gain an edge over the competition and create additional incentives to buy their products. They might, for instance, refund part of the price of a holiday if it was – literally – a rain-off.
- This study provides a broad picture of many sectors that are dependent on the weather, or at least influenced by it. In some cases the connection is immediately obvious (e.g. ice-cream or beer production); in others the dependencies tend to be indirect (in particular areas of mechanical engineering, the auto industry or the retail trade).
- In the coming years, annual growth of the world market in weather derivatives should run at double-digit rates. Their use is also increasing among companies and sectors that have previously not hedged their weather exposure in procurement or sales, either because they were unaware of the great range of possibilities or for (alleged) cost reasons.
- Insurers, reinsurers and banks are displaying greater interest, too. More and more often in future, the insurance industry will incorporate weather derivatives directly into its policies. In addition, financial market specialists are attaching greater importance to the hedging of weather risks when providing loans, rating companies or evaluating shares. It is therefore high time to delve into the opportunities and challenges of the new derivatives.

Josef Auer +49 69 910-31878 (josef.auer@db.com)

**Editor**

Hans-Joachim Frank
+49 69 910-31879
hans-joachim.frank@db.com

Publication Assistant

Astrid Petter
+49 69 910-31755
astrid.petter@db.com

Deutsche Bank Research

Frankfurt am Main
Germany

Internet: www.dbresearch.com

E-mail: marketing.dbr@db.com

Fax: +49 69 910-31877

Managing Director

Norbert Walter

1. The weather was always important

Going right back to Greek and Roman mythology, the weather was always especially important. Both Zeus, the supreme god of the ancient Greeks, and Jupiter, the highest Roman god, were weather gods, i.e. they sent the thunder and lightning, the rain and storms. Back then, the most auspicious way to win the favour of the gods was through sacrifices. What those offerings were supposed to do for the Greeks and Romans, is what so-called weather derivatives can really do for modern-day *homo oeconomicus*: ward off the economic evils of weather events.

The economic fate of many sectors has always depended on the weather. Just think of farming. Weather conditions affect around four-fifths of all economic activity world-wide, either directly or indirectly. Yet, until just a few years ago, there were no financial products that allowed an economically intelligent response to the challenges posed by the weather. The creation of weather derivatives, which took off in the USA from 1997 when the effects of "El Niño" were seared in people's minds, has greatly improved operating conditions for many sectors and companies. However, knowledge about just how dependent different sectors really are on the weather is still very rudimentary, and this is hampering the development of the market.

2. Trigger: need for hedging in the energy sector

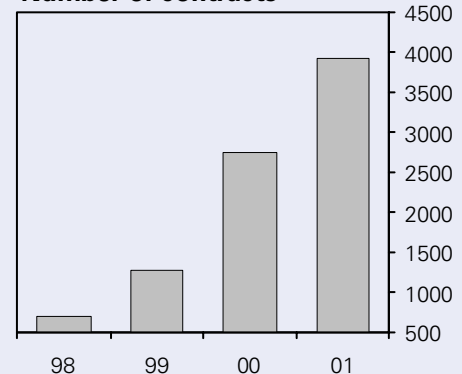
Trade in weather derivatives in North America, Japan and Europe has been pushed by energy suppliers, especially the power utilities. The success of their business is very heavily dependent on fluctuations in temperature, for there is usually a close correlation between electricity sales and daytime air temperature. In the southern US states, for example, electricity sales soar in response to high summer temperatures owing to the increase in power consumption by air-conditioning systems.

Prices in the electricity sector used to be relatively rigid because of the lack of competition, but as deregulation progressed in the USA and later in Europe, power producers were confronted with the additional challenge of marked price fluctuations. The increased pressure on prices and margins made it crucial to have stability on the volume side. There was now a distinct probability that a slump in prices and a fall in volumes would coincide.

While derivative instruments for hedging price risks had existed for decades, there were no such products for controlling volume risks. Given that power producers faced a combination of both risks it is no wonder that they were the ones who created the instrument of weather derivatives, making it possible for the first time to manage weather-related volume risks. Since then, utilities have been able to protect against risks through an intelligent combination of volume and price hedging instruments.

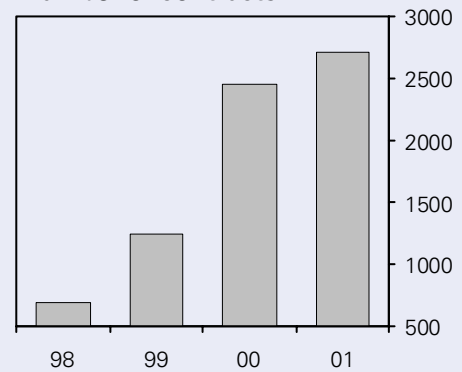
In September 1997 a new type of derivative was born in the US when two power suppliers transacted a weather derivative providing monetary compensation for changes in power sales caused by temperature fluctuations during the winter months.

Weather derivatives: world-wide*)
Number of contracts



*) North America, Asia, Europe and others
Source: PwC/WRMA

Weather derivatives: N. America
Number of contracts



Source: PwC/WRMA

3. Innovative financial derivatives in response to weather risks

Weather derivatives are financial innovations based on weather data, such as quantities of precipitation (rainfall, snow depth), number of days on which it rains, hours of sunshine, air temperature or wind speed. The fact that the underlyings (the weather data) are completely independent of goods or financial markets distinguishes these from other financial derivatives. Typically, an index is created on the basis of the data and quoted on the stock market, for indices make it possible to depict the underlyings continuously over a period of time. The weather variables can be quantified objectively, but cannot be traded or stored as they are not physical assets. Settlement between the seller of the risk (e.g. a utility faced with a weather risk) and the buyer (e.g. a bank) is thus always in monetary units.

4. Many sectors exposed to weather risks

Business in quite a number of sectors is dependent on the weather, or at least influenced by it. In some cases the connection is immediately obvious, whereas in others the dependencies tend to be indirect, discernible only on closer analysis. The following list of weather-dependent sectors is a selection that makes no claim to completeness:

- The weather-dependence of the ice-cream industry is clear. A long, hot summer drives up demand for its cooling product, while a rainy summer leads to disappointing sales.
- The sales of many segments of the drinks industry are similarly affected, e.g. breweries and producers of soft drinks and mineral waters right across the spectrum to energy drinks.
- The weather thus also affects the business of ice-cream parlours, beer gardens, restaurants with outdoor dining, and other forms of open-air selling.
- By contrast, some confectionery manufacturers, such as makers of cough sweets, benefit more from cooler temperatures which are a greater health risk for consumers.
- The performance of virtually all sectors of agriculture is determined by the weather. Segments as disparate as the cultivation of fruit, vegetables, cereals or wine are particularly at risk.
- In forestry, strong winds or drought (fire risk) can threaten large areas of stock.
- In the apparel industry, manufacturers of summer and winter clothing or swimwear, and outdoor specialists all bear a weather risk. And this naturally indirectly affects the textile industry that supplies them.
- The links are pretty clear in the footwear industry, too; one need only think of manufacturers of rainproof boots, winter-wear or sandals.
- Practically all branches of the construction industry, whether in building or civil engineering, are subject to the vagaries of the weather. Particularly in winter, it happens regularly that work has to be halted and bad-weather money paid.

The most common underlying variable in weather derivatives (e.g. options, swaps, caps or floors) in both over-the-counter and exchange trading is the temperature. In 2001 temperature contracts made up 89% of the total number and 96% of the contracted volume. The figures for rain were 7% (number) and 2% (volume).

The immense popularity of temperature-based variables is largely due to historical reasons, for temperature is a key determinant of energy companies' sales (power, gas, district heating or heating oil) and profits.

As a rule, temperature contracts are based on degree-day (DD) indices; these measure the total number of degrees by which daily average temperatures in a fixed period exceed or fall short of an agreed reference temperature (usually 18° C, or in the USA 65° F). A distinction is made between heating degree days (HDD) with temperatures below 18° C and cooling degree days (CDD) with temperatures above this threshold.

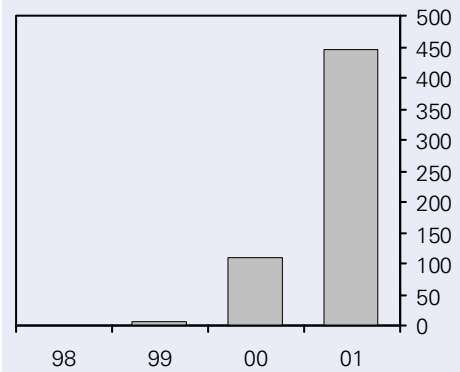
The main exchanges on which weather derivatives are traded are the Chicago Mercantile Exchange (CME) and LIFFE in London.



- In tourism, changes in the weather are important for operators in both domestic and foreign travel. Abnormal weather conditions can upset many calculations; for instance, a lack of snow in the winter season leads, time and again, to worrying figures in winter-sports regions.
- The leisure industry is similarly affected; here the weather plays a role for operators of adventure parks, zoos, swimming pools, golf courses, skating rinks, ski-lifts or entire skiing areas.
- In sport, the uncertainty of the weather influences the success and profitability of events such as large tennis tournaments (Wimbledon, Paris, Hamburg etc.), ski-jumping series or the soccer league season.
- In art and culture, the weather can adversely affect exhibitions and other events such as open-air theatre and concerts (from opera productions and festivals of classical music to large rock concerts).
- In many segments of the classical retail trade that supply weather-dependent products to the end-customer (e.g. stores specialising in clothing, sports goods or garden furniture) the weather indirectly influences sales and constitutes a sizeable risk. Even those who stock a broad range of goods are often unable to completely compensate an unwelcome fall in demand (e.g. by selling more umbrellas and rubber boots when sales of swimwear decline because of rain).
- Weather risks are not confined to the private sector, of course. The public sector is also exposed in many ways. The work of the water, power and gas utilities, local public transport systems, snow-removal services in winter or public swimming pools are just a few examples.
- Even many branches of large industries are indirectly at the mercy of the weather. Sales of construction machinery, for instance, may be influenced by the weather sensitivity of the building industry – besides showing typical seasonal effects. Much the same can happen in farm equipment, wood-processing machinery, clothing machinery or fire-fighting vehicles and equipment. Also weather-dependent are the manufacturers of snow cannons and snow-removal equipment, not to forget the producers of de-icing salt. In the auto industry the weather is a major factor for makers of convertibles if a run of bad summers leads to a fall in demand. Among the suppliers of autoparts, producers of tyres and snow-chains are particularly affected.
- In the energy sector, the weather plays a great role in practically all areas. Power and gas utilities, district heating plants, refineries, dealers in oil, gas and coal, and filling stations have always been affected. And it is immediately obvious that producers of renewable energy based on wind and water power, photovoltaics or solar heating are also heavily dependent on the weather. As renewable energies become more widely used, the economic impact of weather changes will probably increase.

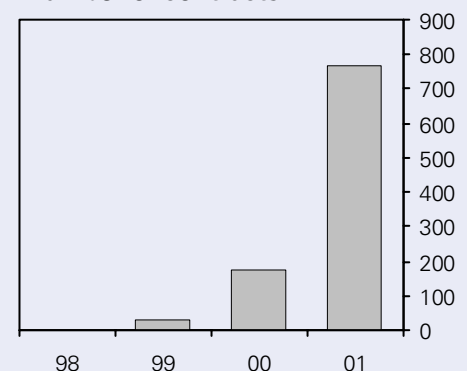
Weather derivatives can also be an interesting marketing instrument, allowing firms to gain an edge over the competition and create additional incentives to buy their products. They might, for instance, refund part of the price of a holiday if it was – literally – a rain-off or if the weather was too cold.

Weather derivatives: Asia
Number of contracts



Source: PwC/WRMA

Weather derivatives: Europe
Number of contracts



Source: PwC/WRMA

5. Still no generally accepted pricing model

In Europe, and especially Germany, weather derivatives are by no means a mature product. Since they were introduced later in Europe than in the USA, potential domestic market players are still some way behind as regards know-how. Awareness of what weather derivatives can offer is relatively low among weather-dependent companies, and the illiquidity of the weather-derivatives market is seen as another major problem in Germany.

The market could be developed by improving know-how, reducing the cost of obtaining regular weather data, and widening their availability, which is still inadequate in some places. This should raise acceptance among potential market participants and ultimately increase the number of active players.

An obstacle that remains, however, is the lack of a generally accepted pricing model. The standard Black-Scholes model used in derivatives trading in stocks or commodities, for example, is not really suitable for weather derivatives. The models used instead are based on "burn analysis" or the more laborious Monte Carlo simulation procedure. Burn analysis uses historical data, while Monte Carlo simulation arrives at a price using randomly generated values. If a generally recognised pricing model were developed, this could greatly improve the transparency of the market.

6. Global market expanding rapidly

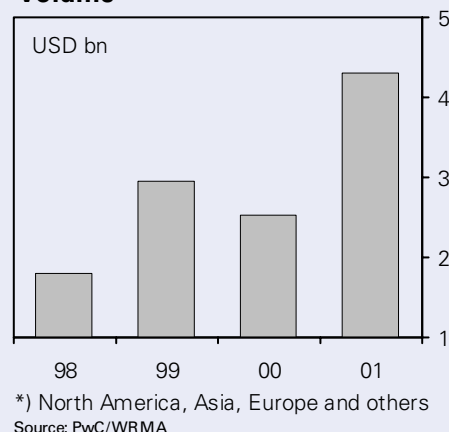
Since its inception in 1997, the market in weather derivatives has expanded very strongly in the USA-Asia-Europe triad, according to a survey by PricewaterhouseCoopers (PwC). In North America, 691 deals were already transacted in 1998, and by the 2001 statistical year (from April 2001 to March 2002) the figure had quadrupled. In Europe, the first two deals were transacted in 1998; by 2001 the figure had risen to 765. Asia, where the first seven transactions were concluded in 1999, registered a jump to 445 in 2001.

In the last statistical year, the markets in Europe and Asia expanded much more dynamically than that in North America: the number of deals was up 345% and 305%, respectively, from the previous year, compared with slightly over 10% in the USA. Despite the rapid expansion in Europe and Asia, though, the USA still dominates the world market with a 70% share of all contracts concluded – far ahead of Europe (not quite 20%) and Asia (slightly over 10%).

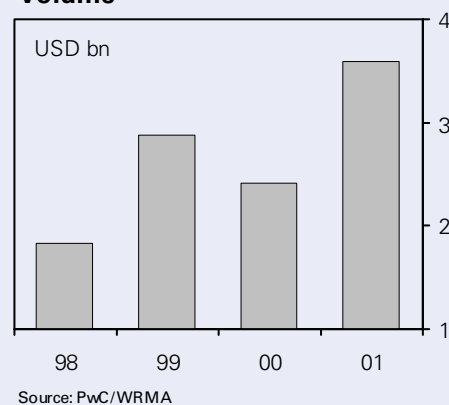
The total number of new deals world-wide climbed 43% in 2001 to roughly 3,940. In terms of contracted volume, the global market for hedging the risks of weather-dependent sectors soared over 70% to around USD 4.3 bn.

The European market virtually exploded, rocketing up to eleven times the pre-year level. The doubling of volume in Asia and the increase by "only" 50% in North America look relatively modest in comparison. It should not be overlooked, though, that the USD 1.2 bn growth in the more mature North American market in 2001 was still more than twice the total volume of the European weather derivatives market in the same year.

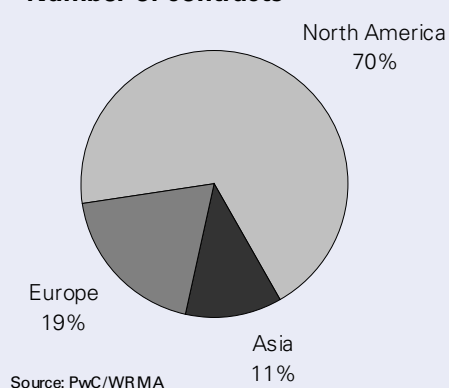
**Weather derivatives: world-wide*
Volume**



**Weather derivatives: N. America
Volume**



**Weather derivatives, 2001
Number of contracts**





7. Double-digit growth rates ahead

In the coming years, annual growth of the world market in weather derivatives should run at double-digit rates. The contracts have widely proved useful in the management of the weather-related exogenous risks in companies' business operations. Companies and sectors that already use them successfully will tend to employ them more, thus contributing to market growth. In addition, the instruments are likely to be used increasingly by companies or sectors that have previously not hedged their weather exposure in procurement or sales, either for cost reasons or because they were unaware of the great range of possibilities. Weather derivatives are also becoming more and more popular as a marketing instrument.

Companies will still face the challenge, though, of integrating weather derivatives into their overall risk management. This would enable the individual company to counter its specific volume, price and other market risks by using an appropriate combination of derivative hedging products. An alternative would be to build up reserves (e.g. inventories) or sufficient equity.

8. Growing interest among private and institutional investors

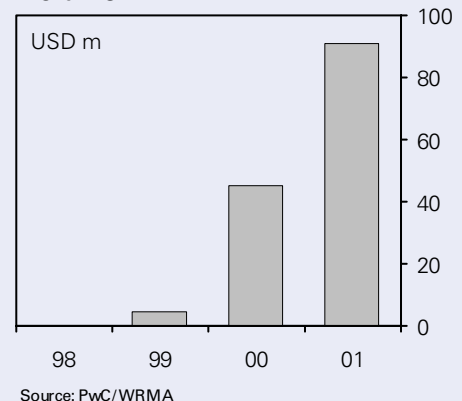
The expansion of the weather-derivatives market will probably be driven not only by affected companies but also by other interested parties.

Contributors to growth will include private and institutional investors who see weather derivatives as a welcome new opening, thanks to the fact that their value performance is usually largely independent of the traditional goods and financial markets. By adding a target-oriented selection of weather risks, portfolio managers can widen and improve their risk diversification to achieve a more favourable risk-return position. Also, where there is a negative correlation, weather derivatives can be used to hedge risks relating to the real economy.

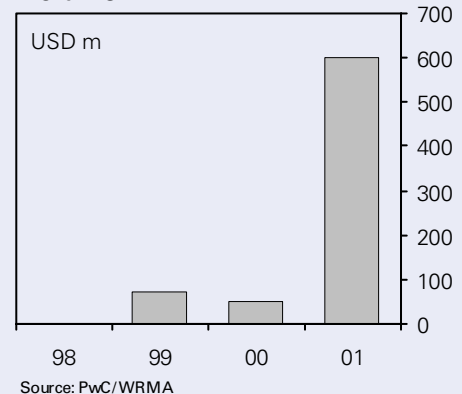
The interest of insurers, reinsurers and banks in weather derivatives is also likely to grow. Banks, for example, will probably offer weather derivatives increasingly in future. More and more often, the insurance industry will incorporate weather derivatives directly into its policies. In addition, financial market specialists will in future attach greater importance to the hedging of weather risks when providing loans, rating companies or evaluating shares. Only in extreme situations will companies in future get away with the now common ploy of blaming disappointing results on weather events.

Finally, the market will also grow as new types of instrument are created and the needs of market participants change. Multiyear derivatives and contracts hedging more than just one weather variable should tend to gain in importance. In one case, Deutsche Bank, acting as adviser to a client, used the variables rainfall and temperature to proxy the risk of snow. The growing sensitisation to catastrophic weather and natural disasters (in the wake of El Niño and the severe flooding in Eastern Europe, for instance) has also aroused interest in the related instrument of catastrophe bonds. And visionaries are already discussing space weather derivatives as protection against the risk of satellites or spacecraft being affected by irregularities caused, for example, by solar winds.

**Weather derivatives: Asia
Volume**



**Weather derivatives: Europe
Volume**



The methods of coping with weather risks have changed considerably since the time of the ancient Greeks and Romans. But the weather remains a fascinating subject of analysis, especially from the economic point of view.

Josef Auer +49 69 910-31878 (josef.auer@db.com)

If you have further questions, Deutsche Bank's specialists will be glad to help:

- Hector Freitas
Commodity Structuring and Sales
Tel: +49 69 910-36539
- Dr. Günter Lassak
Risk Management Services
Tel: +49 69 910-36480

© 2003. Publisher: Deutsche Bank AG, DB Research, D-60272 Frankfurt am Main, Federal Republic of Germany, editor and publisher, all rights reserved. When quoting please cite „Deutsche Bank Research“.

The information contained in this publication is derived from carefully selected public sources we believe are reasonable. We do not guarantee its accuracy or completeness, and nothing in this report shall be construed to be a representation of such a guarantee. Any opinions expressed reflect the current judgement of the author, and do not necessarily reflect the opinion of Deutsche Bank AG or any of its subsidiaries and affiliates. The opinions presented are subject to change without notice. Neither Deutsche Bank AG nor its subsidiaries/affiliates accept any responsibility for liabilities arising from use of this document or its contents. Deutsche Banc Alex Brown Inc. has accepted responsibility for the distribution of this report in the United States under applicable requirements. Deutsche Bank AG London being regulated by the Securities and Futures Authority for the content of its investment banking business in the United Kingdom, and being a member of the London Stock Exchange, has, as designated, accepted responsibility for the distribution of this report in the United Kingdom under applicable requirements. Deutsche Bank AG, Sydney branch, has accepted responsibility for the distribution of this report in Australia under applicable requirements.

Printed by: HST Offsetdruck Schadt & Tetzlaff GbR, Dieburg.

ISSN Print: 1438-9185 / ISSN Internet: 1438-9193