Weather Risk Advisory

An Introduction to Weather Derivatives

9 March 2001

An introduction to weather derivatives

- What is weather risk?
- What are weather derivatives?
- Understanding market dynamics
- Sourcing and working with weather data
- Examples of weather derivative use

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What is weather risk?

Weather risk is the potential adverse impact of the weather on corporate costs, revenues, and cashflow

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What impact does weather risk have?

- An estimated 70% of all businesses face weather risk
  - approximately $1 trillion of the US economy
- In a survey of 200 top US utility company annual reports, 80% cited weather as a major determinant of earnings performance
- About 50% claimed weather was responsible for poorer than expected performance
- However, until recently, there has been a lack of effective methods to manage weather risk

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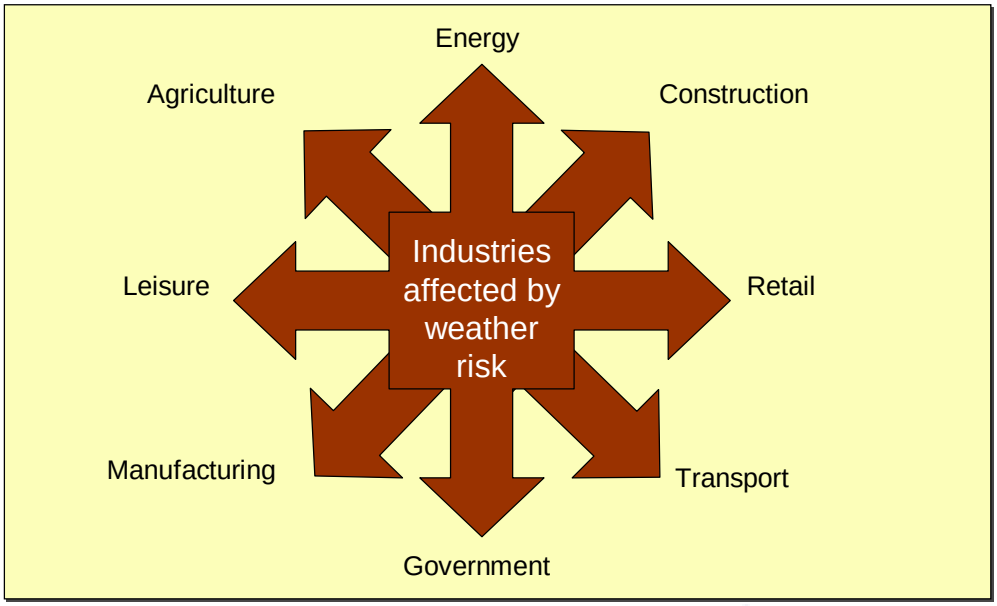
Which industries are affected?



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What are weather derivatives?

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What are weather derivatives?

- Weather derivatives are financial products such as swaps and options
- They allow companies to protect themselves against weather risk, just as they use financial products to hedge price risk
- They can be based on any independently-measurable weather factors, such as temperature or rainfall, as recorded in a specific reference location(s)

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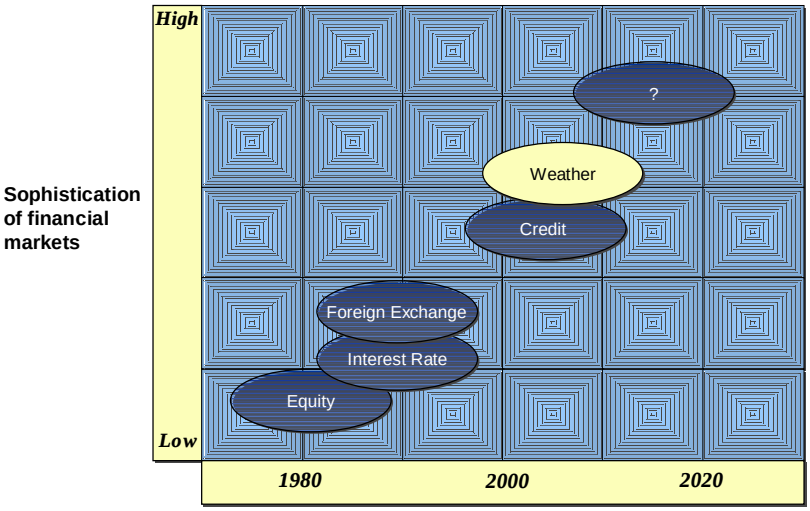
New and innovative instruments facilitate the hedging of an increasing range of risks



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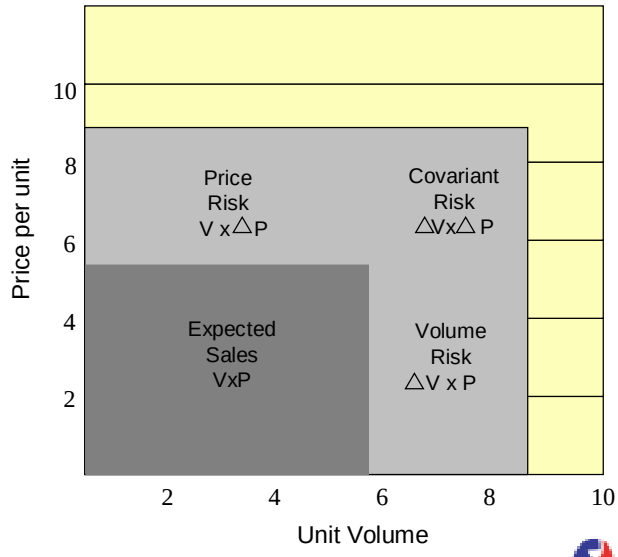
There are many derivative instruments at utilities' disposal to hedge price risks, but weather derivatives are unique in enabling organisations to manage their volume risks



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How do weather derivatives compare to weather insurance?

- Weather insurance covers high-risk, low-probability events (such as severe wind storms)
- Weather derivatives shield revenues against lower risk, high-probability events (such as mild winters reducing heating demand)
- Weather derivatives can have benefits over insurance in that they remove moral hazard

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What underlying indices are used?

- Heating Degree Days and Cooling Degree Days (HDDs and CDDs) are measures of temperature that closely reflect energy demand
- The standard reference temperature in Europe is 18°C (65ºF in the US)
- Number of HDDs for that day is the greater of (18ºC - the daily mean temperature) and zero (because negative values do not apply)
- CDD indices are calculated by switching the terms of the subtraction step, so it becomes the greater of (the daily mean temperature - 18ºC) and zero

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How are these indices used in practice?

- HDDs / CDDs are summed over a period
- The term of the deal may be a full year or just one season, e.g.
  - "Heating": November - March
  - "Cooling": May – September

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Other indices used

- Average temperature
- Maximum or minimum temperature
- Critical temperature events
- Rain and snowfall
- Wind speed

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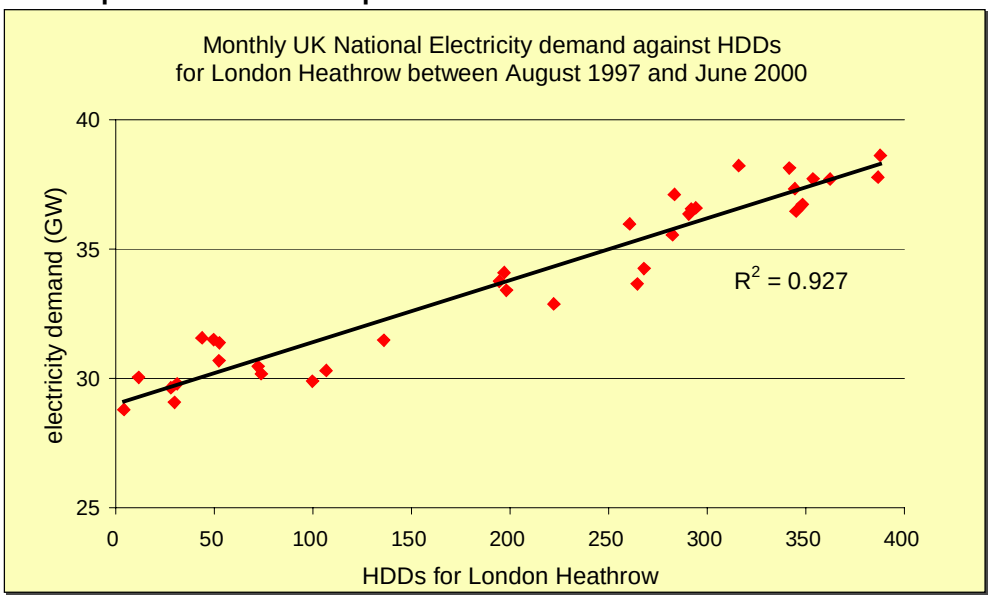
An example of the relationship between demand and HDDs



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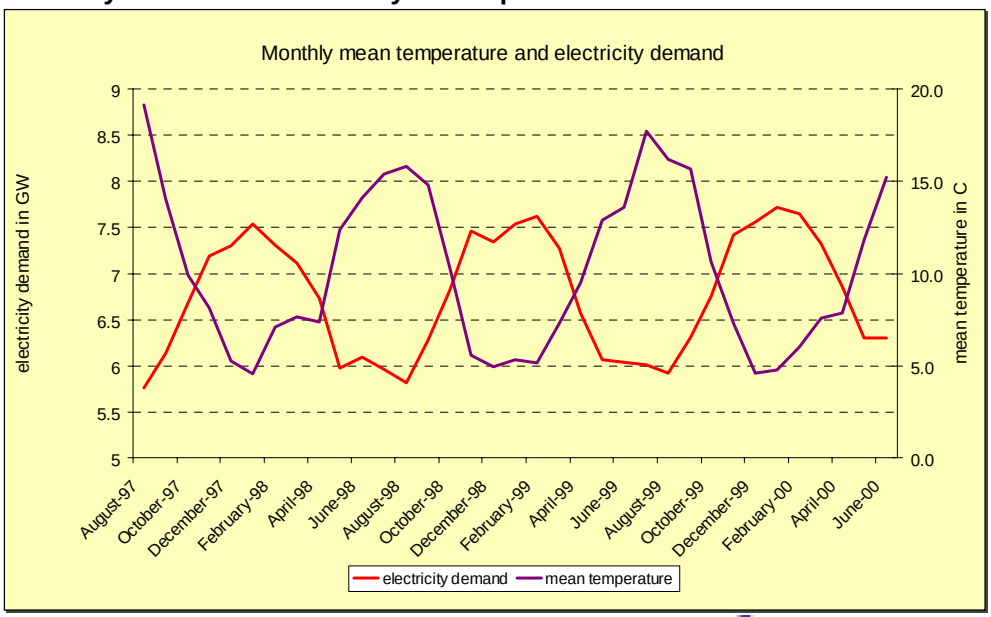
Electricity demand is affected by air temperature



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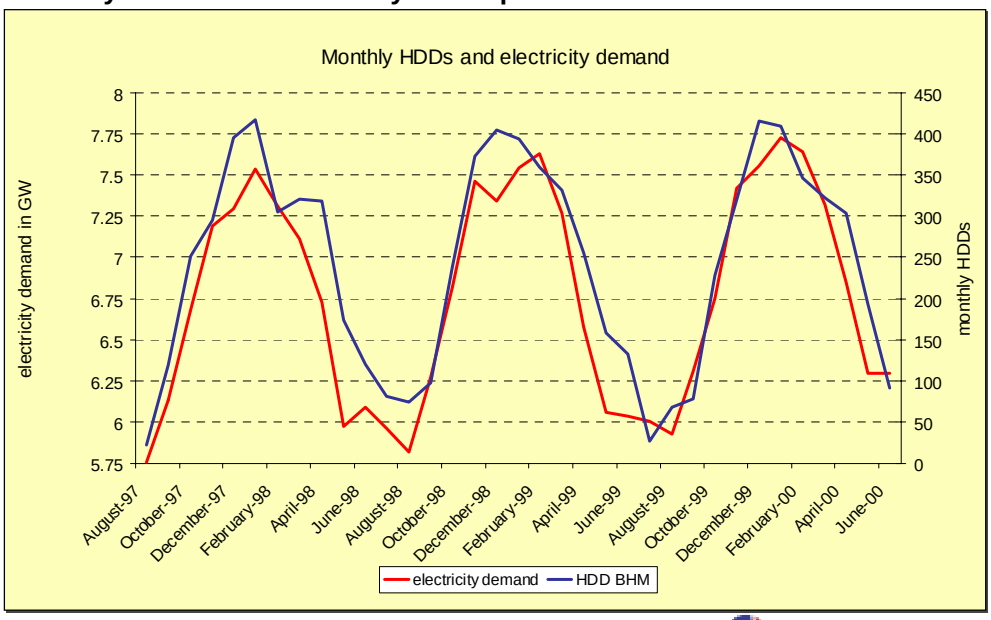

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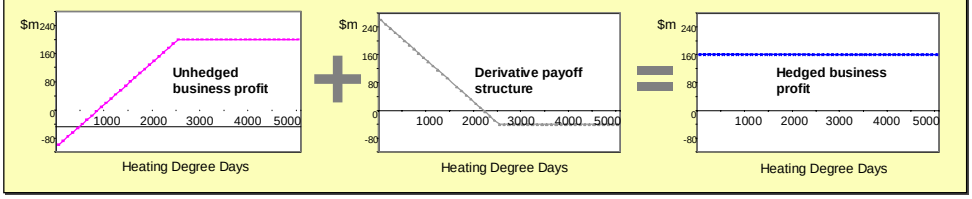
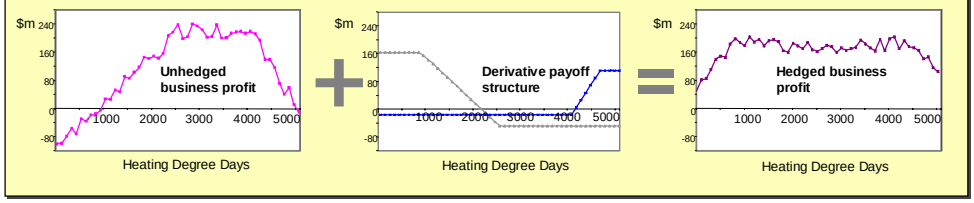
How do HDD deals work?

Ideal World



Real World



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Identifying appropriate weather variables

- Can translate weather impacts into weather variables
  - e.g. An ice cream company says “hot days affect sales”. This could be quantified using temperature, humidity or wind speed.
  - e.g. A theme park company says “wet weather affects customer numbers”. This could be quantified using rainfall, cloud cover or sunshine hours.
  - e.g. An electricity company notices that demand increases if a sunny day turns rainy. This could be quantified using temperature, rainfall, sunshine, wind speed or cloud cover.
- Can quantify which weather variable accounts for the largest weather impact

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Identifying candidate weather indices

- Can establish which weather indices and what time interval to use

  e.g. A gas supply company finds that demand increases on cold days

  Can use:

  HDDs - with a standard or specific reference temperature

  Average temperature

  Critical event - when temperature passes a defined value

  Temperature can be quantified on an hourly, daily or monthly basis

  e.g. Average temperature can be compared to business data on a hourly, daily, weekly, or longer time interval.

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Understanding market dynamics

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The US weather derivatives market continues to dominate

- At least $1 trillion of the US economy is sensitive to weather risk
- The weather derivatives market began in the US in 1997 and more than 4500 deals have now been transacted there
- It is currently dominated by energy-related hedging with notional principal outstanding estimated at $7.5 billion
- The US market has developed beyond the fledgling stage, and market-maker Koch Industries reports rapidly-increasing liquidity - they are currently transacting 2-5 deals each day and expect further increases in demand for weather products in preparation for the summer season
- The US market is expected to grow to $300 billion within the next few years

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The European weather derivatives market

- The first European deal was struck in September 1998 between Enron and Scottish Hydro Electric
- There have now been approximately 200 trades in Europe, of which 80% are swaps
- The total notional principal is approximately £60million
- All deals trade with a ceiling, which can be up to around £30million
- The market is not characterised by the same dominance of a handful of energy players, as in the US
- The Weather Risk Management Association's second European meeting was held in November 2000 and was attended by over 120 people, representing more than 80 organisations

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Players from a wide range of sectors operate in the weather derivatives market

- Sophisticated utilities, e.g. Enron (Enron Online)
- Banks, e.g. Société Générale (SGweather.com)
- Reinsurers, e.g. Swiss Re (ELRiX.com)
- Hedge funds & speculators
- Pension funds
- From mid-2001, exchange-trading on LIFFE will bring in new players

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Sourcing and working with weather data

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Selecting the correct datasets is important but is not a major challenge

- Selecting reference locations is surprisingly easy – correlations between sites is high
- The optimum amount of data depends on the extent of de-trending
- 10-30 years is normally recommended, though it seems European energy companies tend to use around 20 years
- It is commonly noted that US weather data is free, whilst that covering Europe is “expensive”

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Identifying appropriate weather stations

- Basis risk
  - Could use a small local station manned by volunteers or an automatic, well-traded location at a distance
  - Correlation between sites can be high, therefore distance from the weather station does not necessarily increase basis risk significantly
- Liquidity
  - How well traded is the location?
- Data quality and availability
  - Are there easily accessible historical records?
- Basket of locations
  - Would a combination of many stations be best?

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Obtaining historical weather data

- **Raw data or clean data?**
  - Raw data has missing data points, and changes in the station's location or instruments will not have been corrected for
  - Raw data is cheap and has not been altered in any way, allowing you to decide what cleaning techniques are applied to it
  - Cleaned data can be purchased. However, it is expensive and the cleaning techniques used may not be publicly available
- **Where do you get weather data from?**
  - Procure data from national meteorological services or other providers such as internet portals
  - US weather data is free, whilst that covering Europe is "expensive"; e.g. an annual license for historical UK clean and raw data sets, and limited European raw data sets from the UK Met Office costs approximately £3,000

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The quality, availability and cost of weather data varies widely by country

Country	*Availability and timeliness*	*Ongoing data cost*	*Historic data cost*	*Quality*
France	9	8	7	9
Germany	6	7	4	6.5
Netherlands	8	9	6	8
Norway	9	9	9	7
Spain	6	7	10	5
Sweden	9	9	5	7
UK	9	9	6	9
US	9.5	10	10	9

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Understanding the integrity of the historical weather is the key to successful use of weather derivatives

- Cleaning the data is vital, though it is possible to purchase cleaned data which has had the standard techniques applied to it
- Enhancing the data, for example by correcting for station changes, is also essential to ensure informed negotiations
- De-trending is subjective, but with mean levels changing due to warming or cooling, the effects can be substantial

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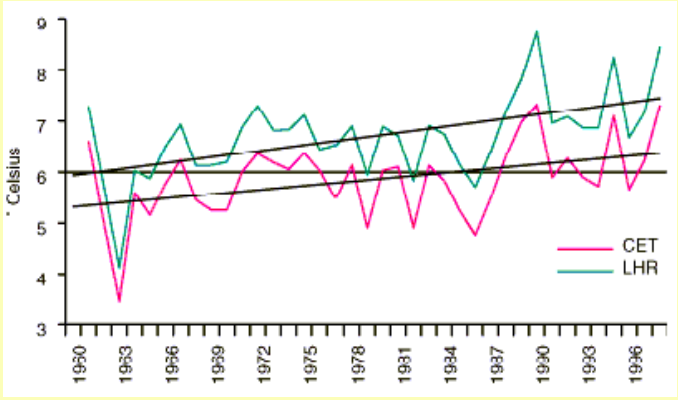
Detrending weather data example

- Central England Temperature series shows a general warming trend
- Heathrow temperature series has a larger warming trend due to urbanisation



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Example data problems

- **Stockholm**
  - a long term warming trend was detected for winter months since 1989
  - underground road heating had been installed to melt ice
- **Oslo**
  - the raw historical data series for Oslo airport does not refer to the same location prior to 1998
  - the new Oslo airport opened in 1998
- **Berlin**
  - the data was supposed to be hourly but on inspection it turned out to be 3 hourly for about 8 of the last 30 years
  - the data collection officer had filled in three consecutive hourly boxes

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Creative use of weather derivatives

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Fixed-price energy bills

- A European electricity supplier has recently introduced a set cost domestic energy service, aimed at low-income households
  - Energy bills are set annually, and do not vary with consumption
  - Weather derivatives can be used to offset the risk of a cold winter increasing demand
  - The company is taking an opposite position to its competitors, making them ideal counterparties

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The future

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How will the market develop?

- Increased awareness
  - Extreme weather will heighten interest in weather risk hedging
- Increased number of players
  - More active involvement from the banking sector
- Increased range of risks
- Securitisations and use of weather derivatives within project financing
- More exchange traded products
- Increased role for the online brokers
- Use of weather derivatives as part of marketing campaigns

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Conclusions

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Conclusions

- The weather derivatives market has grown rapidly since its inception in 1997
- The market appears to be approaching a critical mass that would lead to weather derivatives being used as a matter of course
- Managers who do not hedge their company's weather risk are speculating with shareholders money
- The financial implications of not using a weather derivative far outweigh the current tight spreads seen in the market

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