

*Case study :*  
*The volatility and price mechanisms*  
*on the German electricity market*

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## *Agenda*

### The German electricity market

- Market volatility
- Supply structure
- Demand structure
- Price history
- Price Models
- Forecasting

## *Price volatilities of spot prices*

- High price volatilities increase the uncertainty and risk of future prices
- A measure of price volatility is needed
- Price changes can be explained through the daily price returns
- Experiences only from the financial market available

## Price volatilities

- Description through the price returns

$$R_{t,set} = \ln(P_t / P_{t-1})$$

- The volatilities will be explained with the variance

$$s = \sqrt{s^2} = \sqrt{VAR} = \left[ \frac{\sum_{i=1}^T (R_i - \bar{R})^2}{(T-1)} \right]^{\frac{1}{2}}$$

- Mostly annualised with  $s_{Ann} = s \sqrt{M}$  as 30 days volatilities (MA 30)
- In the financial market: every price fixing is a trading day
- In the spot market: every price fixing is a delivery day

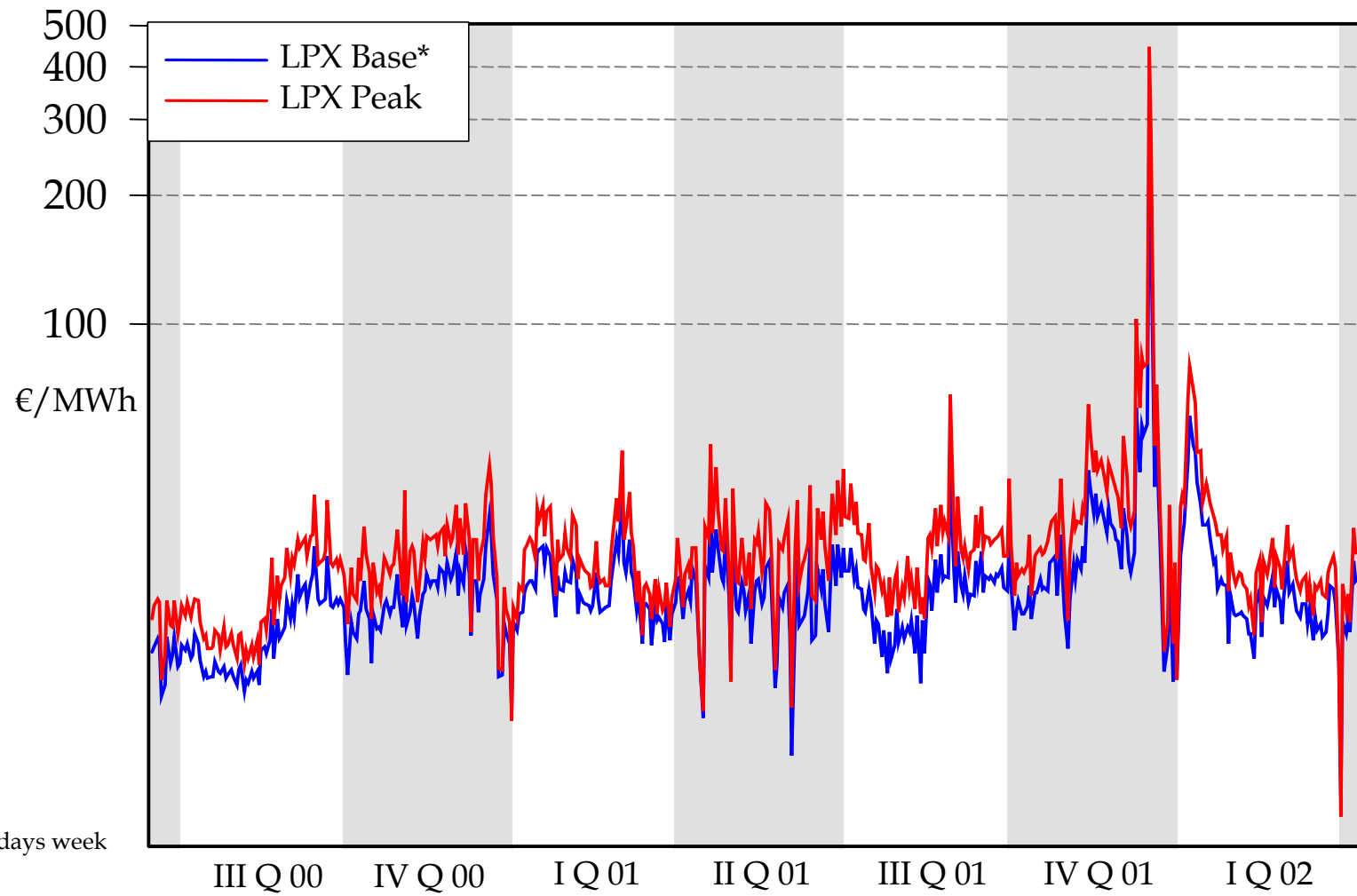
## *Comparison of volatilities*

	<b>Annu. volatility [%]</b>	
<b>Dollar/DEM</b>	11	(9/99 – 8/01)*
<b>DAX</b>	19	(1992 – 1999)**
<b>Oil (Brent)</b>	38	(9/99 – 8/01)*
<b>Gas Day Ahead</b>	102	(9/00 – 8/01)*
<b>LPX Base</b>	295	(6/00 – 8/01)*
<b>LPX Peak</b>	372	(6/00 – 8/01)*

\* Own calculation

\*\* Hafner *Solutions* 01/00

## Spot prices in Germany

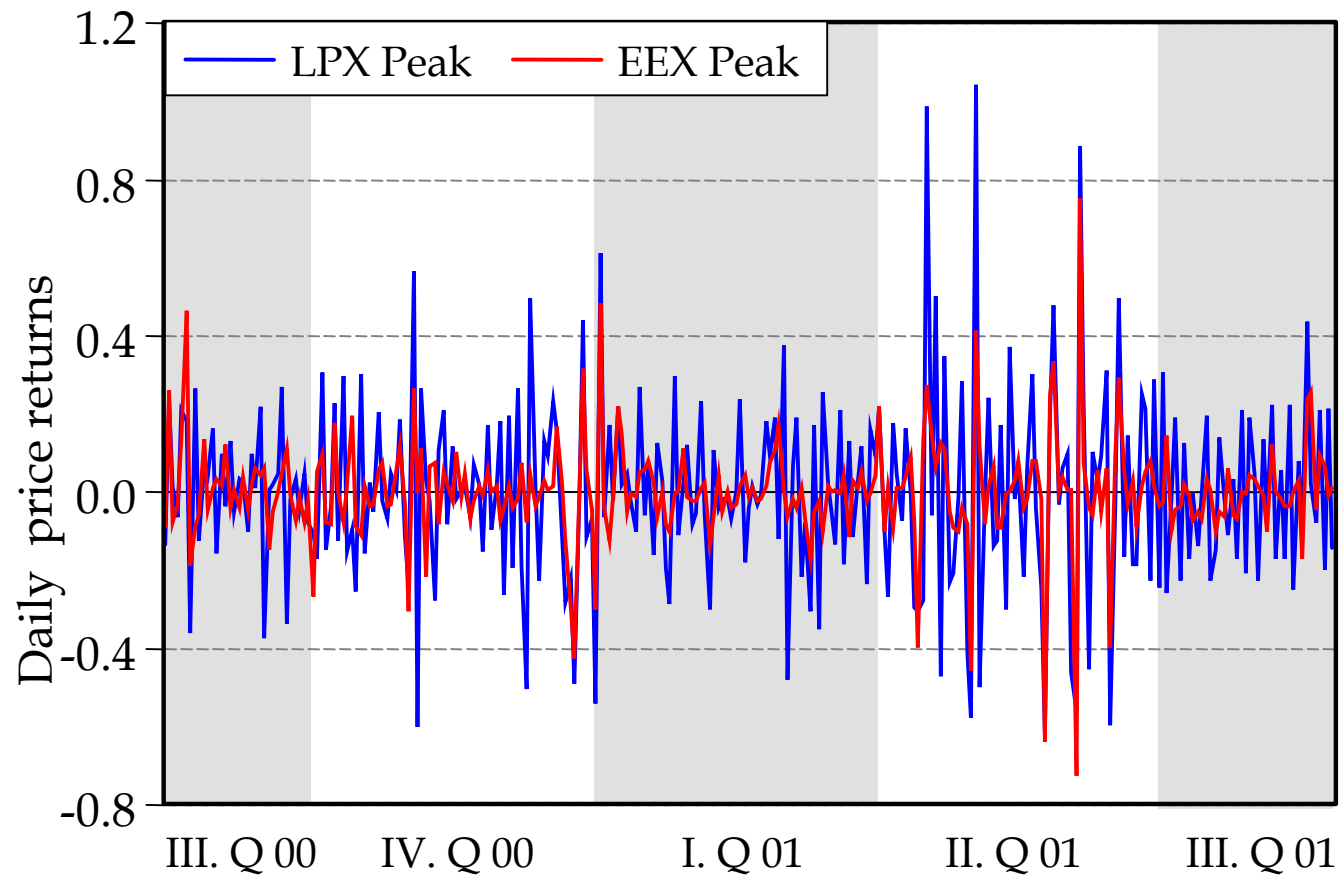


\* 5 days week

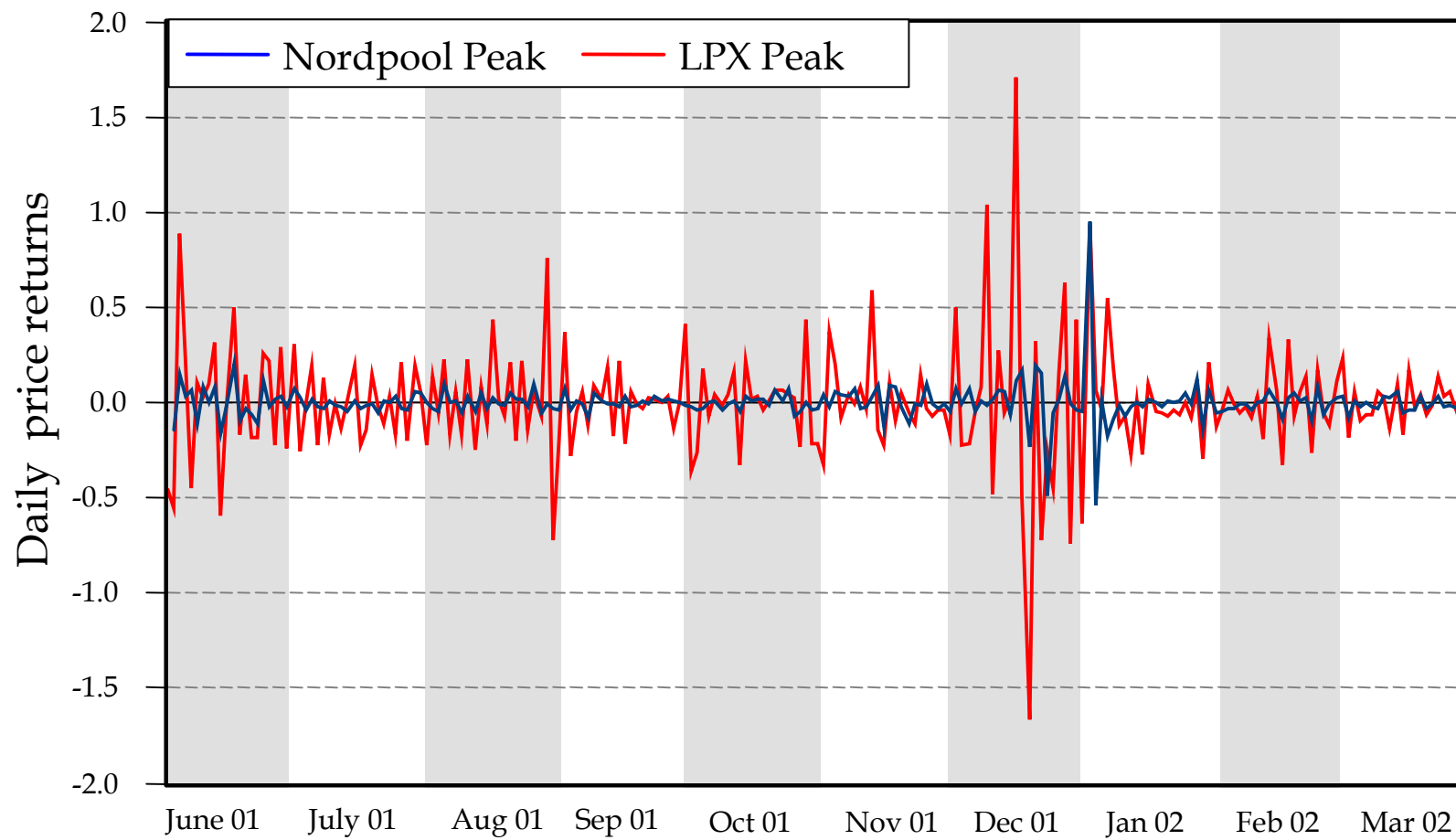
## *Price behaviours*

- High volatility
- Sudden jumps
- Regime shifts
- Strategic prices due to oligopolistic prices
- Seasonal changes
- Dependence on temperatures
- Dependence on supply and demand

## *Daily price returns in Germany*



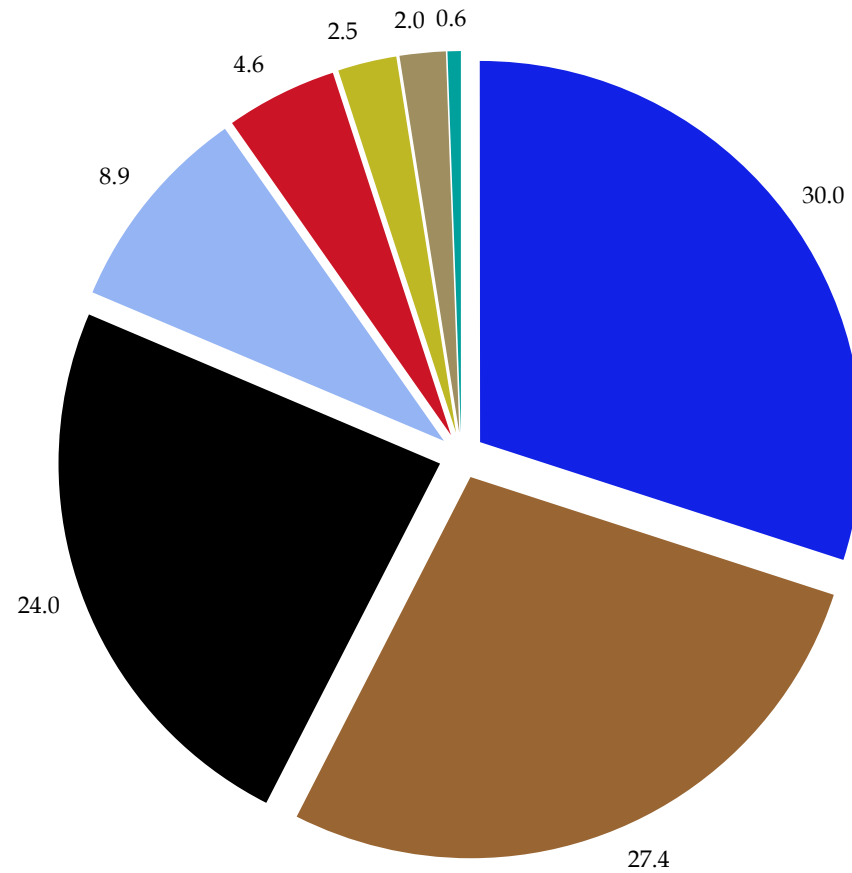
## *Daily price returns cross comparison*



## *Reasons for high price volatilities of spot prices*

- Supply and Demand Structure
- Behaviour of market players
- Microstructure of PX
- High or low liquidity

## Sources of electricity production [%]\*

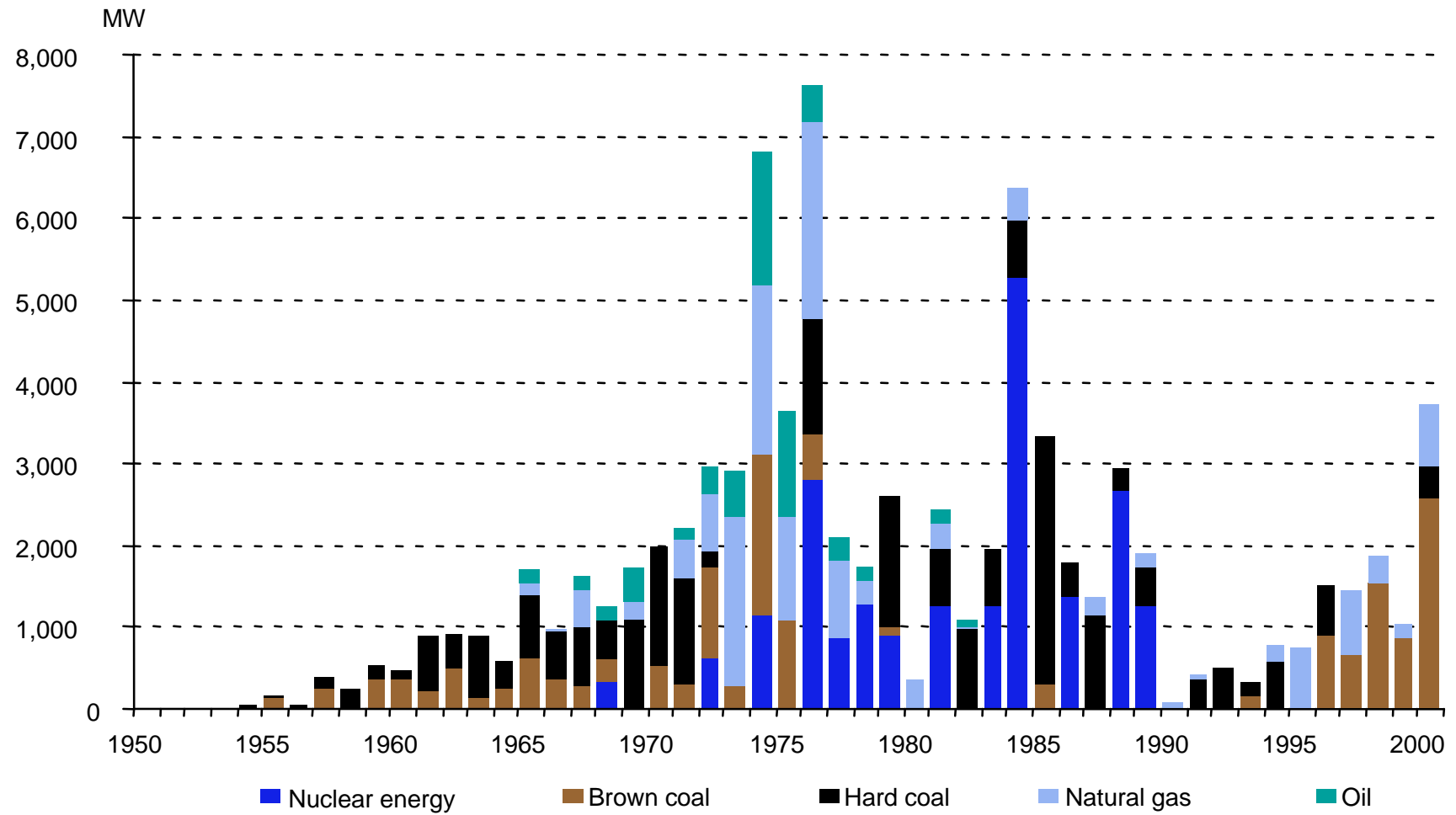


\* In 2001 of total 570 TWh

■ Nuclear energy ■ Brown coal ■ Hard coal ■ Natural gas ■ Water ■ Wind ■ Oil ■ Others

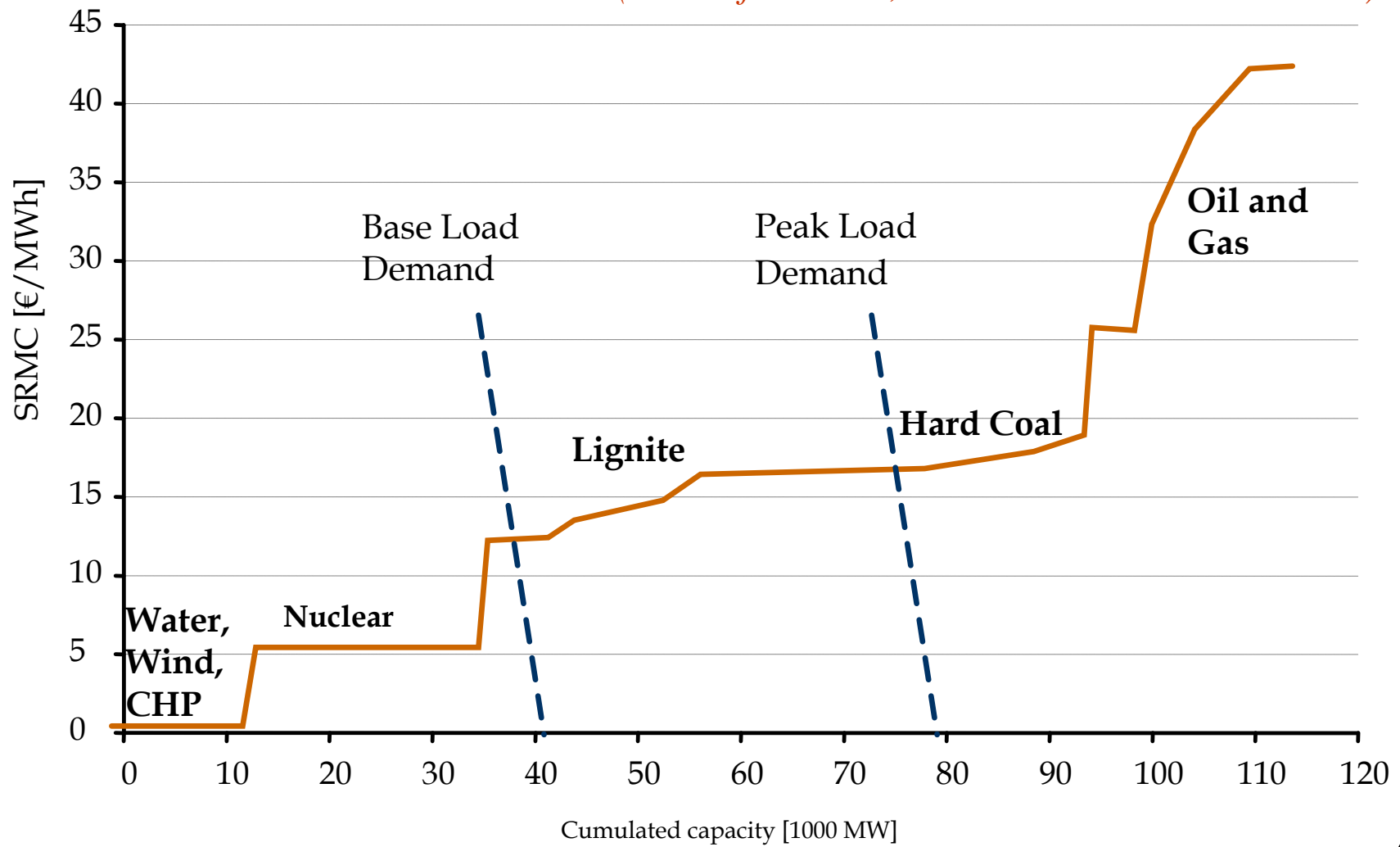
# Structure of the German power plants

(source: LBD)

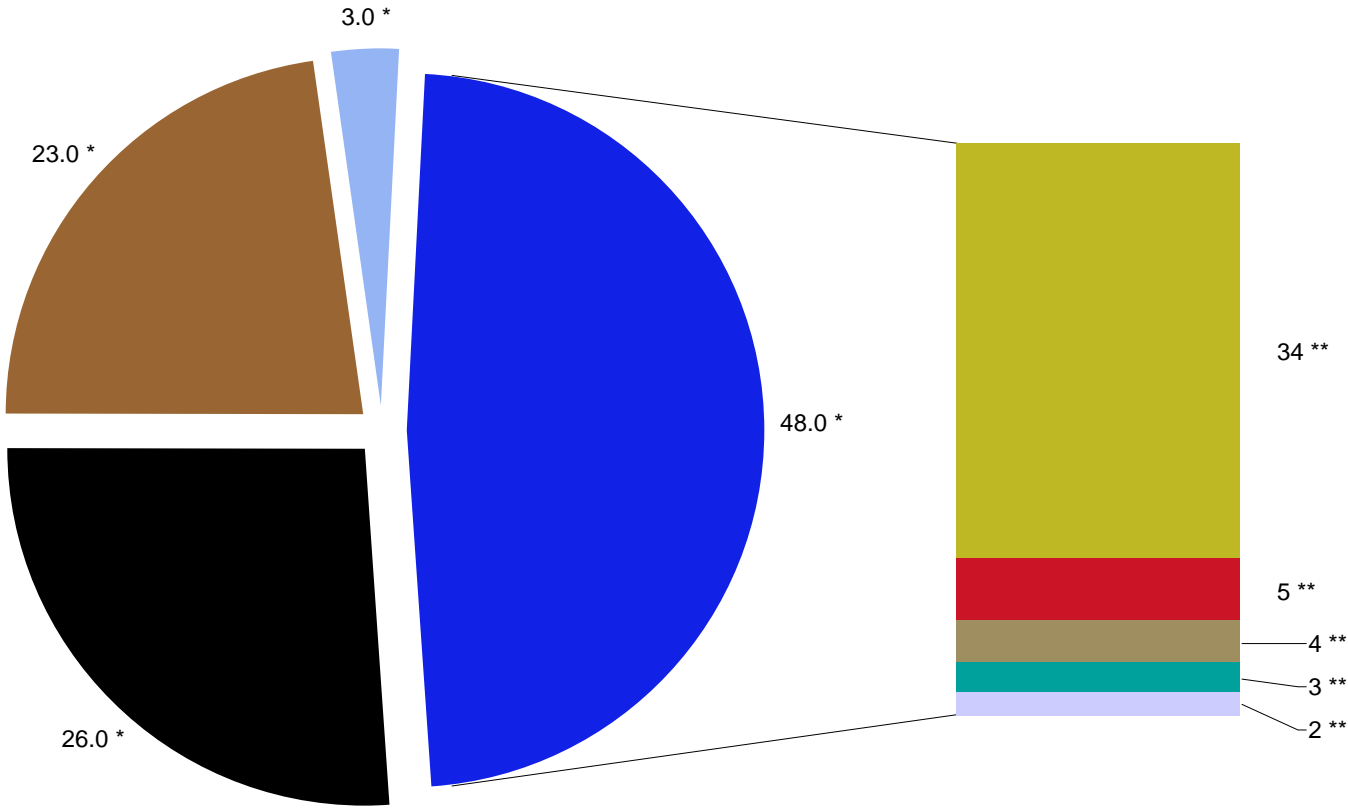


# SRMC of Germany in 1999

(At low fuel costs; source : Frontier Economics)



# Demand structure

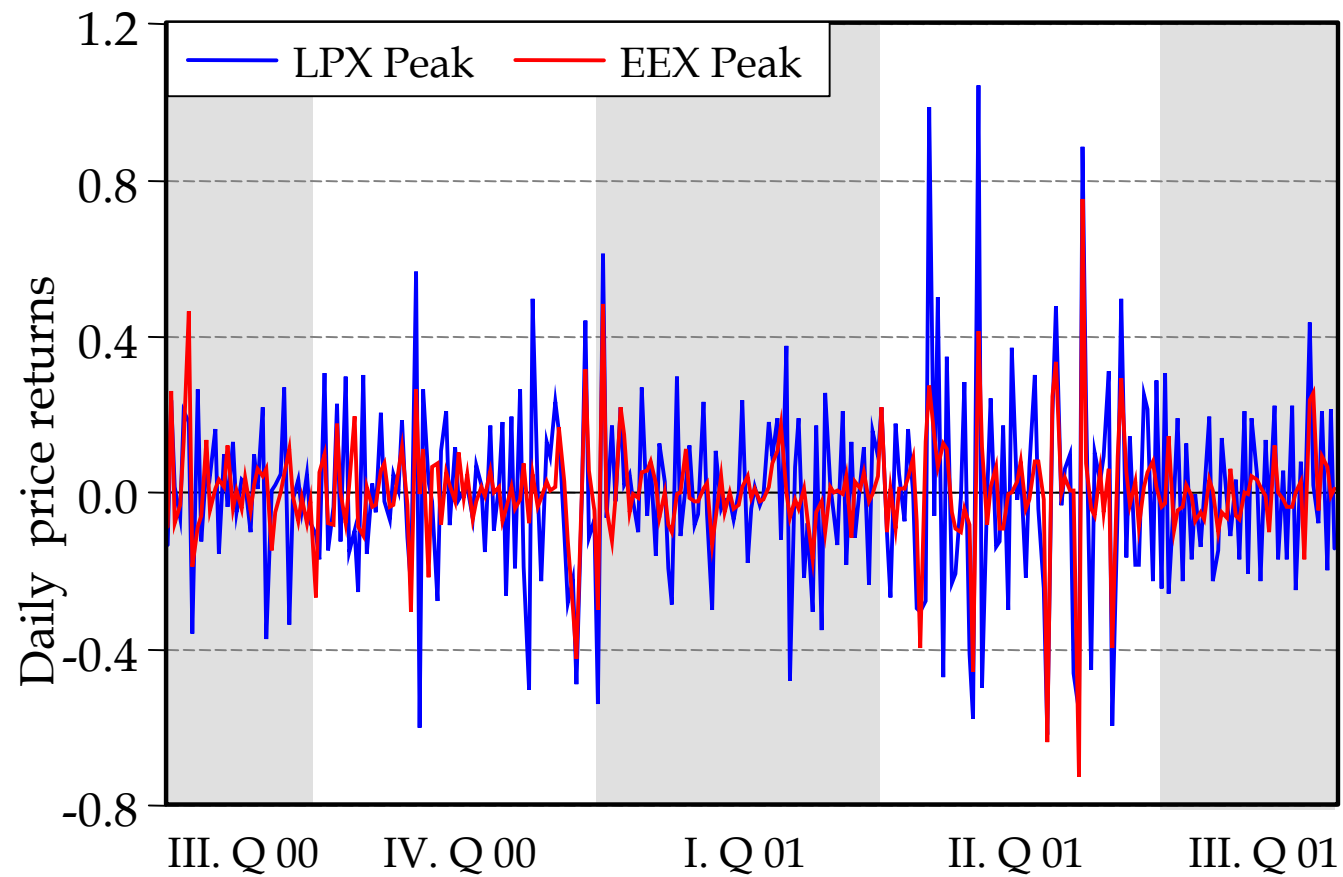


\* In 2001 (Source: Schiffer)  
 \*\* of total, own estimation

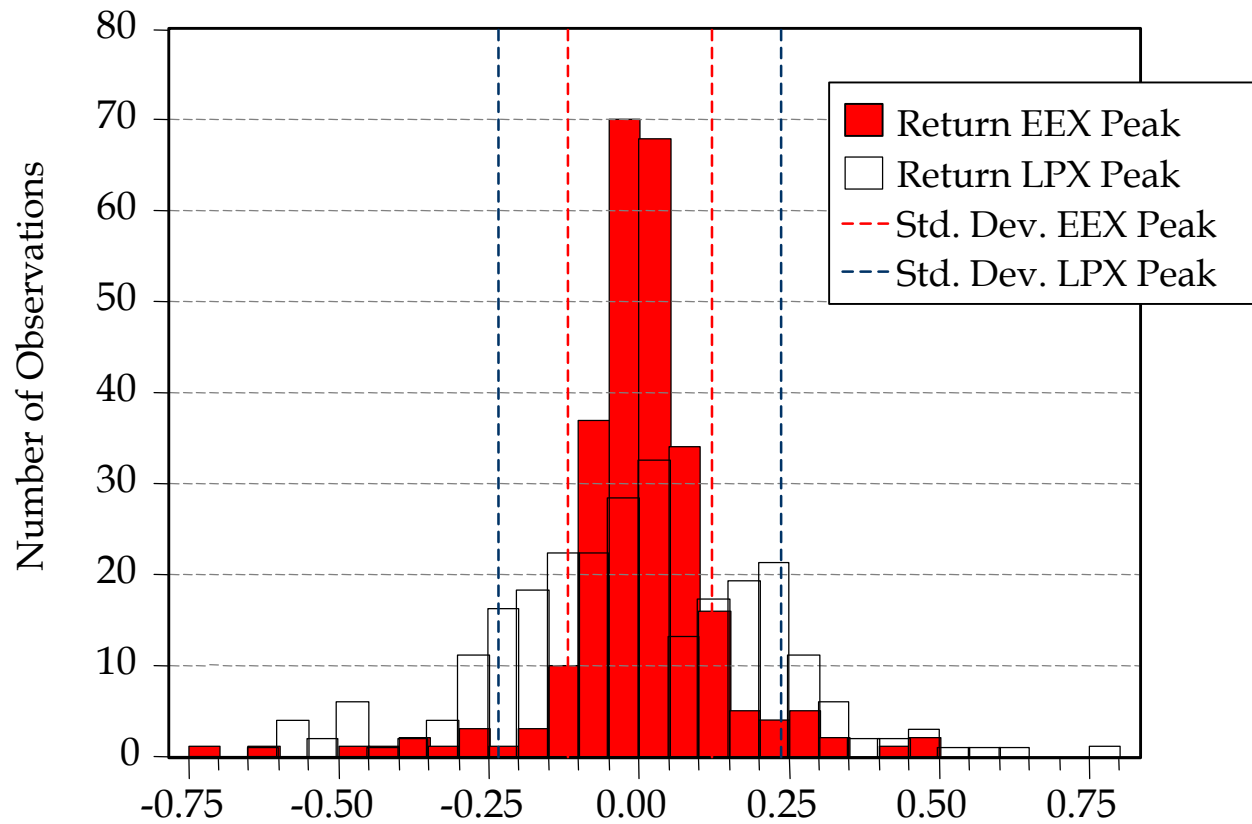
- Industrial
- Household
- Small and medium Business
- Transportation
- Chemicals
- Steel and Aluminum
- Automotive
- Bahn
- Others



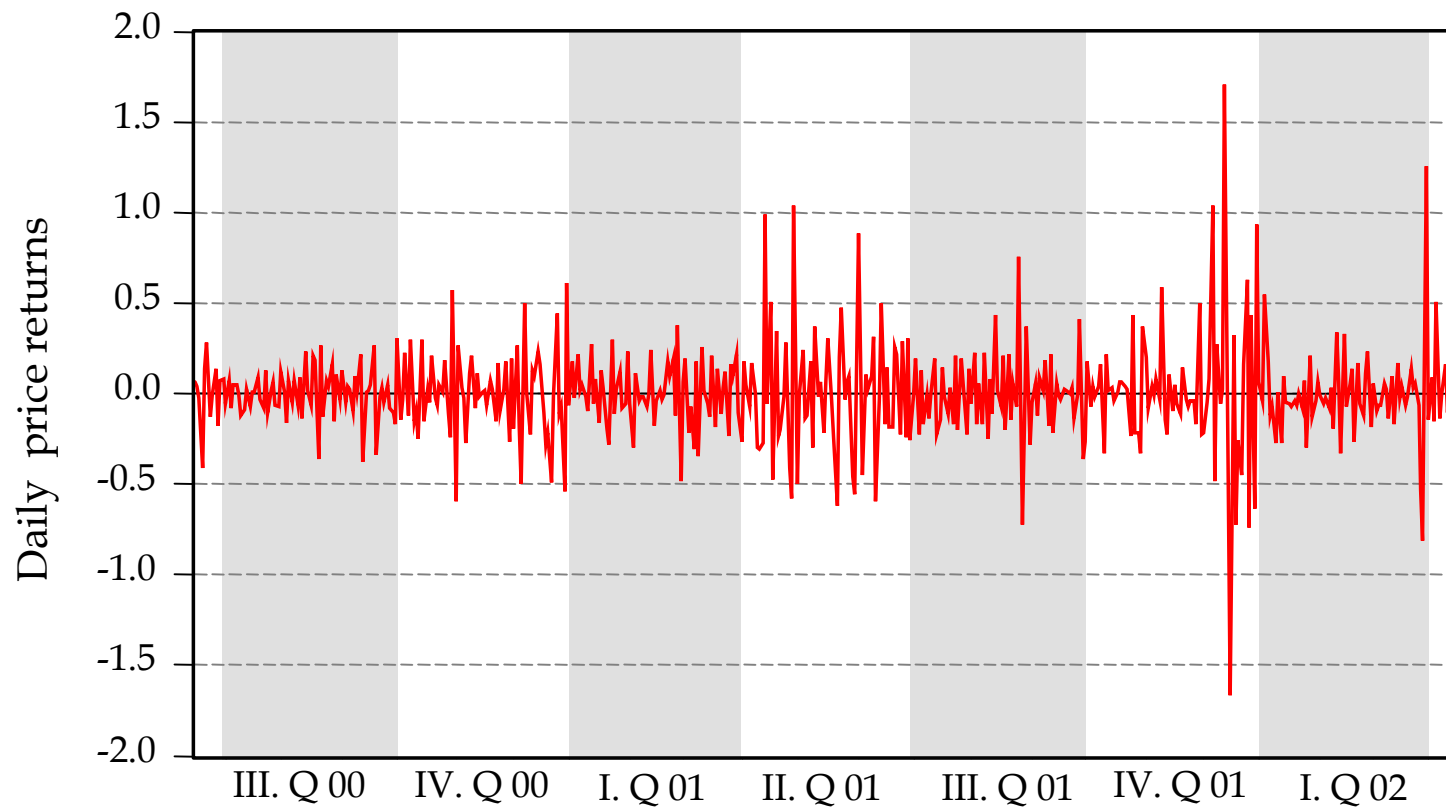
*Why are there in the same market different volatilities ?*



## *Effect of microstructure on price volatility*

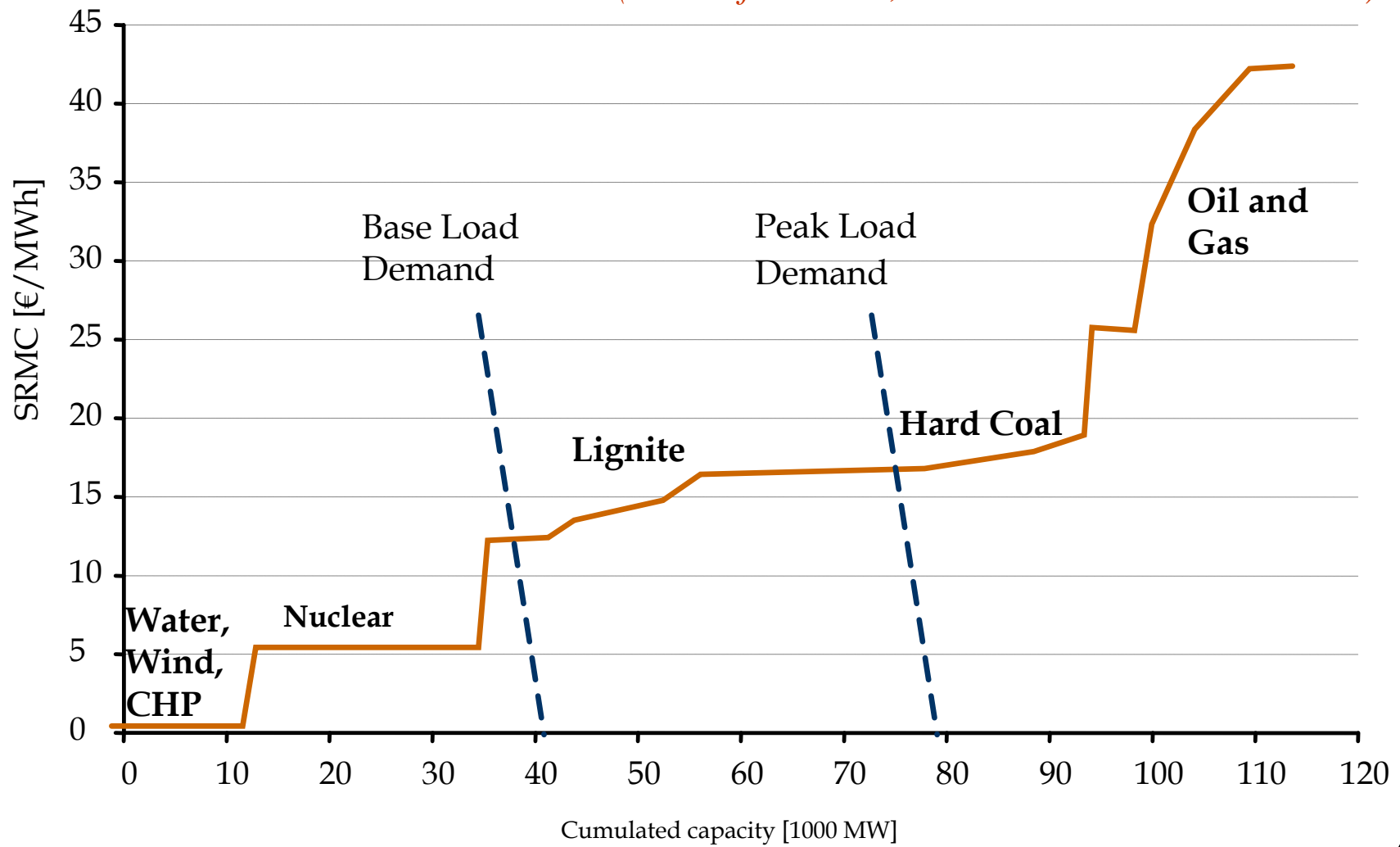


## *Price or time depending volatility*

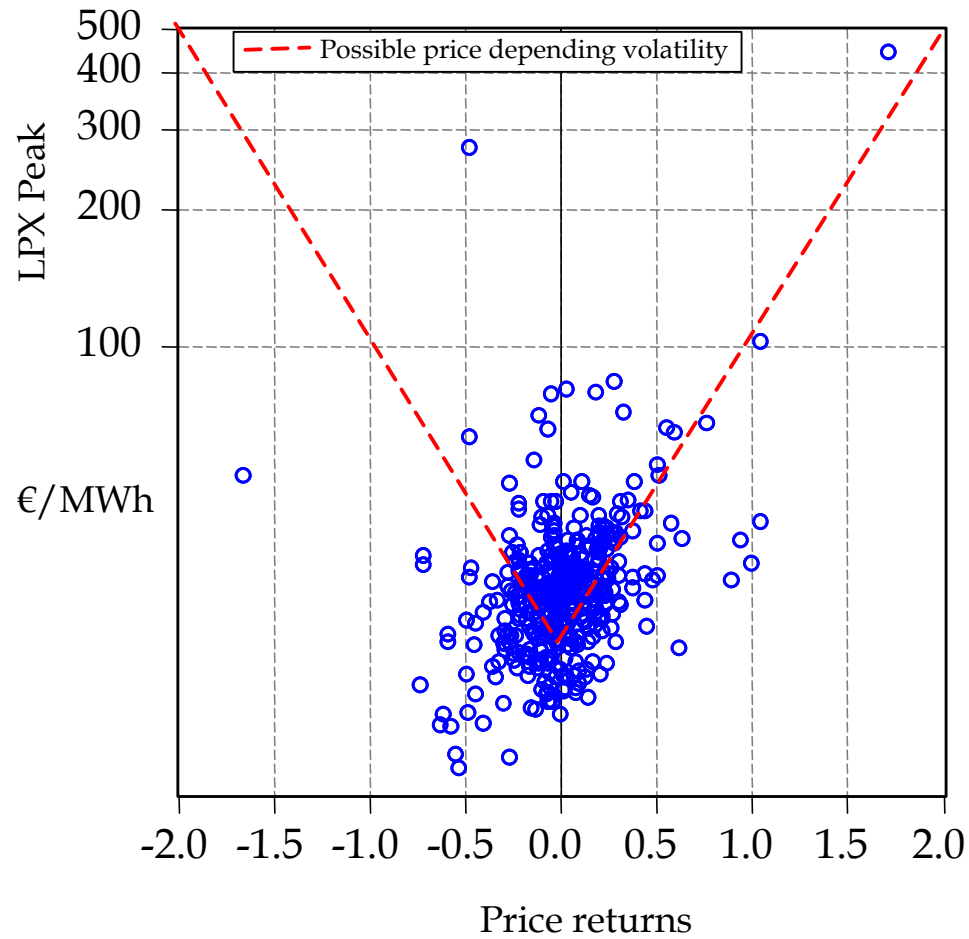


# SRMC of Germany in 1999

(At low fuel costs; source : Frontier Economics)



# *Effect of price depending volatility*



## *The choice of the forecasting model*

Every model can be useful:

	time horizon	product	frequency	needed resources	externals
<b>Market description</b>	none, short term	all	daily/yearly	high	yes
<b>Delphi method</b>	short to long term	all	max every quarter	medium	no
<b>Technical analysis</b>	short term	forward/ futures	very often	low	yes
<b>SRMC</b>	short to long term	spot	very often	Mittel	yes
<b>Merit Order</b>	short to long term	spot	daily	high	(yes)
<b>Econometric</b>	short term	spot forward futures	very often	high	yes
<b>Game theory</b>	(ex post) short term	spot	daily	high	(yes)

## *Forecasting volatilities*

- Historical volatilities are known
- Future volatilities must be estimated
- Methods to estimate future volatilities:
  - Historical volatilities will be transferred in the future
  - Econometric methods (ARCH/GARCH)
  - Random walk model where volatility will be time depended (Heteroskedasticity)

## *Models for the (adjusted) price-Return*

Random-Walk-Model for the price return

$$\frac{dp_t}{p_t} = \mathbf{m} \cdot dt + \mathbf{s} \cdot d\mathbf{j}$$

Single factor *Mean-Reversion* model

$$\frac{dp_t}{p_t} = \mathbf{m} \cdot dt + \mathbf{k} \cdot \ln \left[ \frac{L_t}{p_t} \right] + \mathbf{s} \cdot d\mathbf{j}$$

**m** drift

$\sigma$  standard deviation

$L_t$  long term price

$d\mathbf{j}$  standard brownian motion

**k** reversion rate  $\approx 0,5$  (t-statistic = 6,19)

## *Price model must cover following behaviours*

- High volatility
- Sudden jumps
- Regime shifts
- Strategic prices due to oligopolistic prices
- Seasonal changes
- Dependence on temperatures
- Dependence on supply and demand

## *Stochastic / econometric models*

The definition of econometric models and regression analysis cover the same type of models

- The variable to be modelled will be explained with endogen variables
- Time lags are significant
- Model can be run univariate (autoregressive) or multivariate (VAR – models)
- Mean reversion behaviour of electricity can be modelled (i.e. with AR – models)
- Price volatilities can be integrated

## *LPX Peak price forecast (February 2002)*

