# Pensions,Lotteries,Financial Markets: Measuring Statistical Risk


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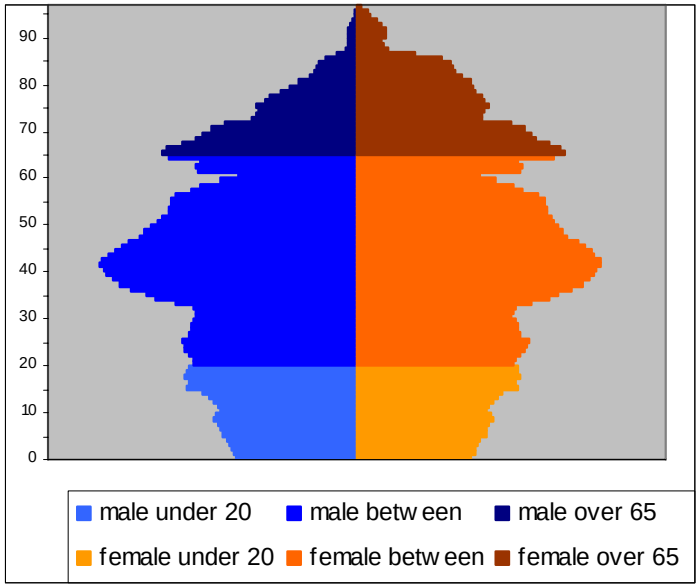
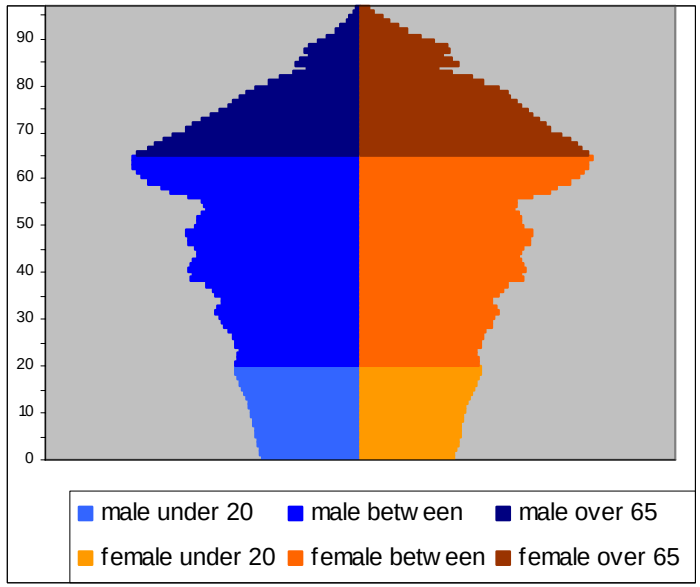
# Pension Systems

- **How risky are the demographics ?**

Germany




2007




2030



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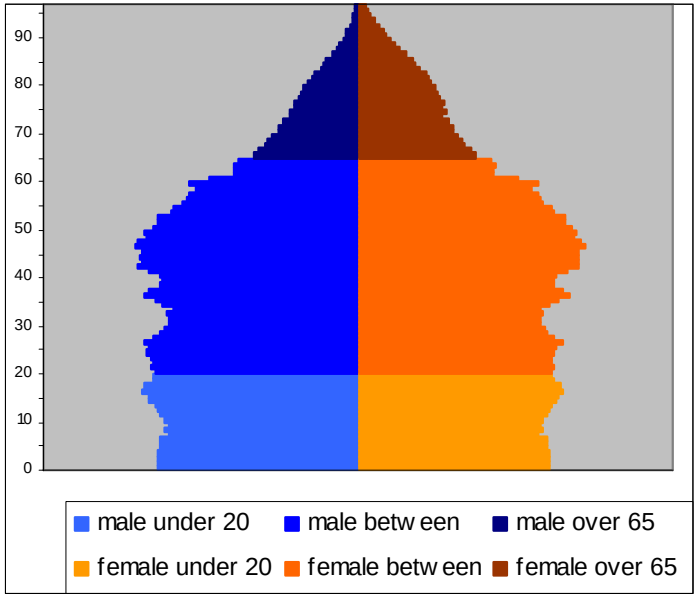
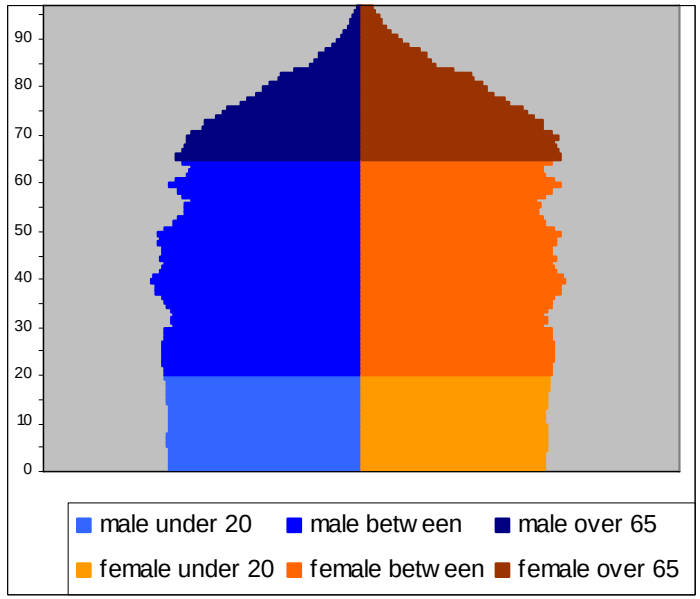
# Pension Systems

- **How risky are the demographics ?**

USA




2007




2030



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# Measuring Statistical Risk

- Basis for rational decisions
- Dynamic data visualization
- Fast computing of different scenarios

# Demographic Risk Management

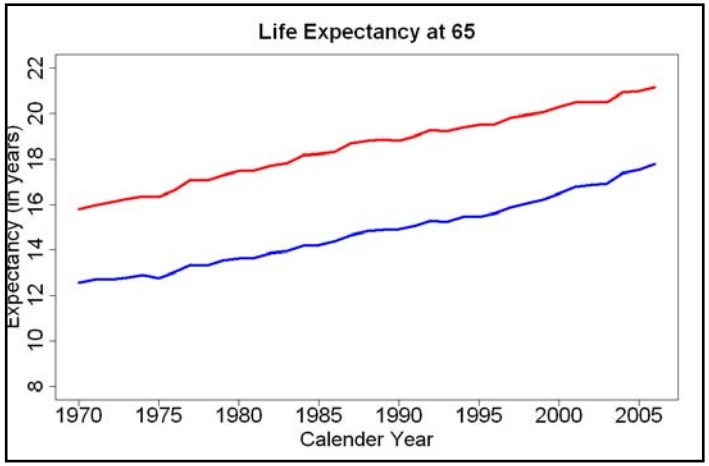
- Population Dynamics
- Government Pensions

  Until 2030 relative to 2006
  - premium rate rises up to 30%
  - costs rise by 50%
- Private Life Insurance

# Private Life Insurance as Solution?

- Premium depends on future life expectancies
- Mortality deviated dramatically from forecasts

| Estimation of Cohort Life Expectancy at 65 | | | | |
|---|---|---|---|---|
| | Male | | Female | |
| | DAV 1994 R | DAV 2004 R | DAV 1994 R | DAV 2004 R |
| For 2004 | 21 years | 24 years | 25 years | 27 years |
| For 2040 | 24 years | 30 years | 28 years | 34 years |



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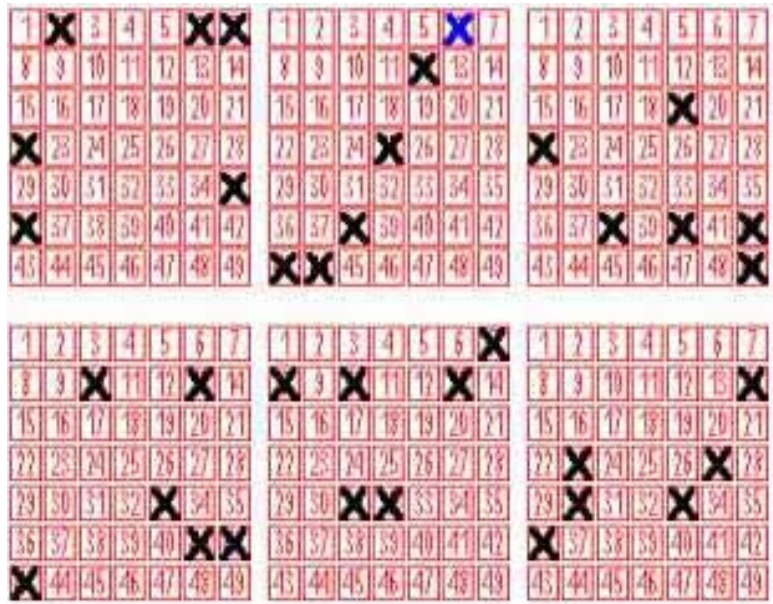
# Demographic Risk

- Path-breaking technological or medical innovation
- Financial disaster for retirees
- Huge costs for the pay-as-you-go social system
- Systematic risk for capital markets

# Lotteries

- Are there „winning numbers“ ?
- How much cash predicts the theory ?
- What are the odds ?



# Some history

- Genova: „5 out of 90“ for the city council
- Casanova: lotto in France
- French court discovers income source


# Lotteries

- **What are the odds ?**

  **$s$ possible numbers $\Longrightarrow$ „choose $r$ from $s$“**

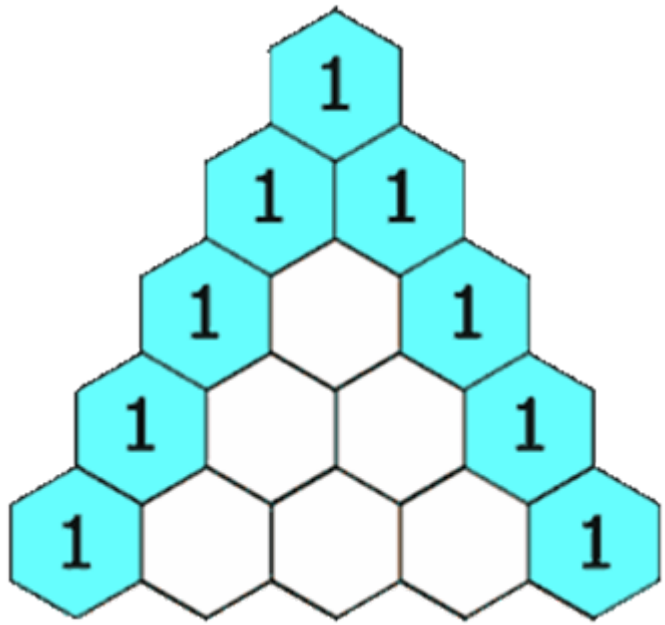
  **number of possibilities:**

$$\binom{s}{r} = \frac{s!}{r!(s-r)!}$$

| | | |
|---|---|---|
| D, CZ | $s=49,\ r=6$ | 13 983 816 |
| A, CH | $s=45,\ r=6$ | 8 145 060 |

# Lotteries

- Pascal‘s Triangle
- Binomial Coefficients

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# Lotteries

- **Are there „winning numbers“ ?**

**(1, 8, 15, 22, 29, 36); (19, 27, 29, 31, 38, 44);**

**(2, 15, 14, 1, 16, 1, 18, 20, 5)= (B,O,N,A,P,A,R,T,E) ?**

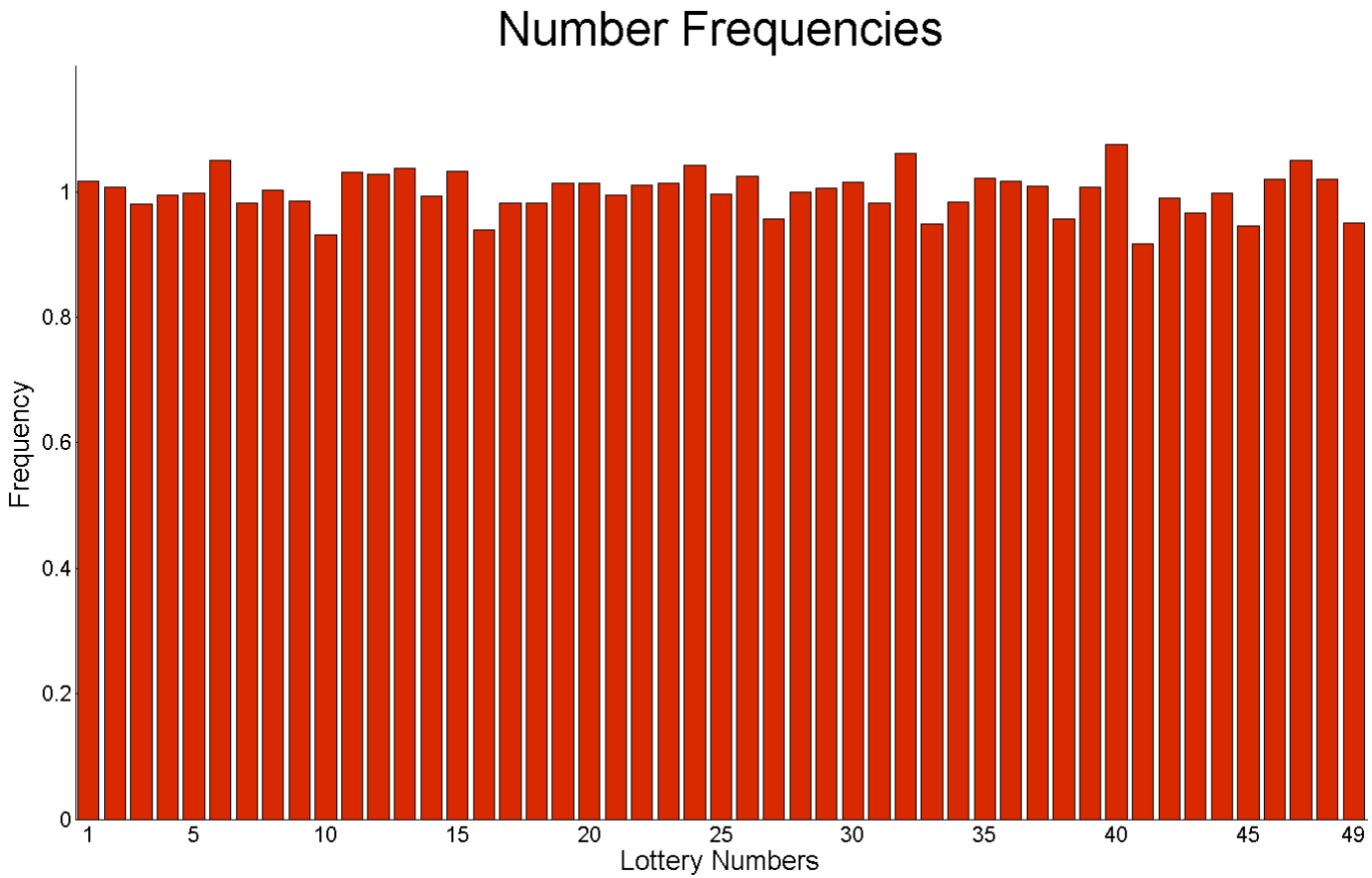
| | | | | | | |
|---|---|---|---|---|---|---|
| ~~1~~ | 2 | 3 | 4 | 5 | 6 | 7 |
| ~~8~~ | 9 | 10 | 11 | 12 | 13 | 14 |
| ~~15~~ | 16 | 17 | 18 | 19 | 20 | 21 |
| ~~22~~ | 23 | 24 | 25 | 26 | 27 | 28 |
| ~~29~~ | 30 | 31 | 32 | 33 | 34 | 35 |
| ~~36~~ | 37 | 38 | 39 | 40 | 41 | 42 |
| 43 | 44 | 45 | 46 | 47 | 48 | 49 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 8 | 9 | 10 | 11 | 12 | 13 | 14 |
| 15 | 16 | 17 | 18 | ~~19~~ | 20 | 21 |
| 22 | 23 | 24 | 25 | 26 | ~~27~~ | 28 |
| ~~29~~ | 30 | ~~31~~ | 32 | 33 | 34 | 35 |
| 36 | 37 | ~~38~~ | 39 | 40 | 41 | 42 |
| 43 | ~~44~~ | 45 | 46 | 47 | 48 | 49 |

popular „9“ frequency=3.1%

unpopular „43“ frequency=1.4%

# Lotteries

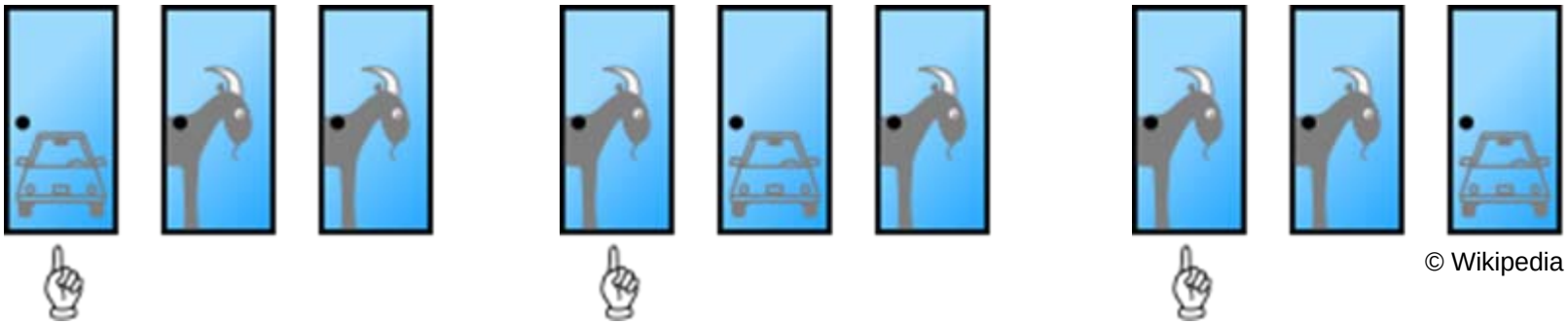



**Czech Lotto 1957-2008**

**$X^2$-test for uniform distribution**

# Lotteries

- **Monty Hall problem**



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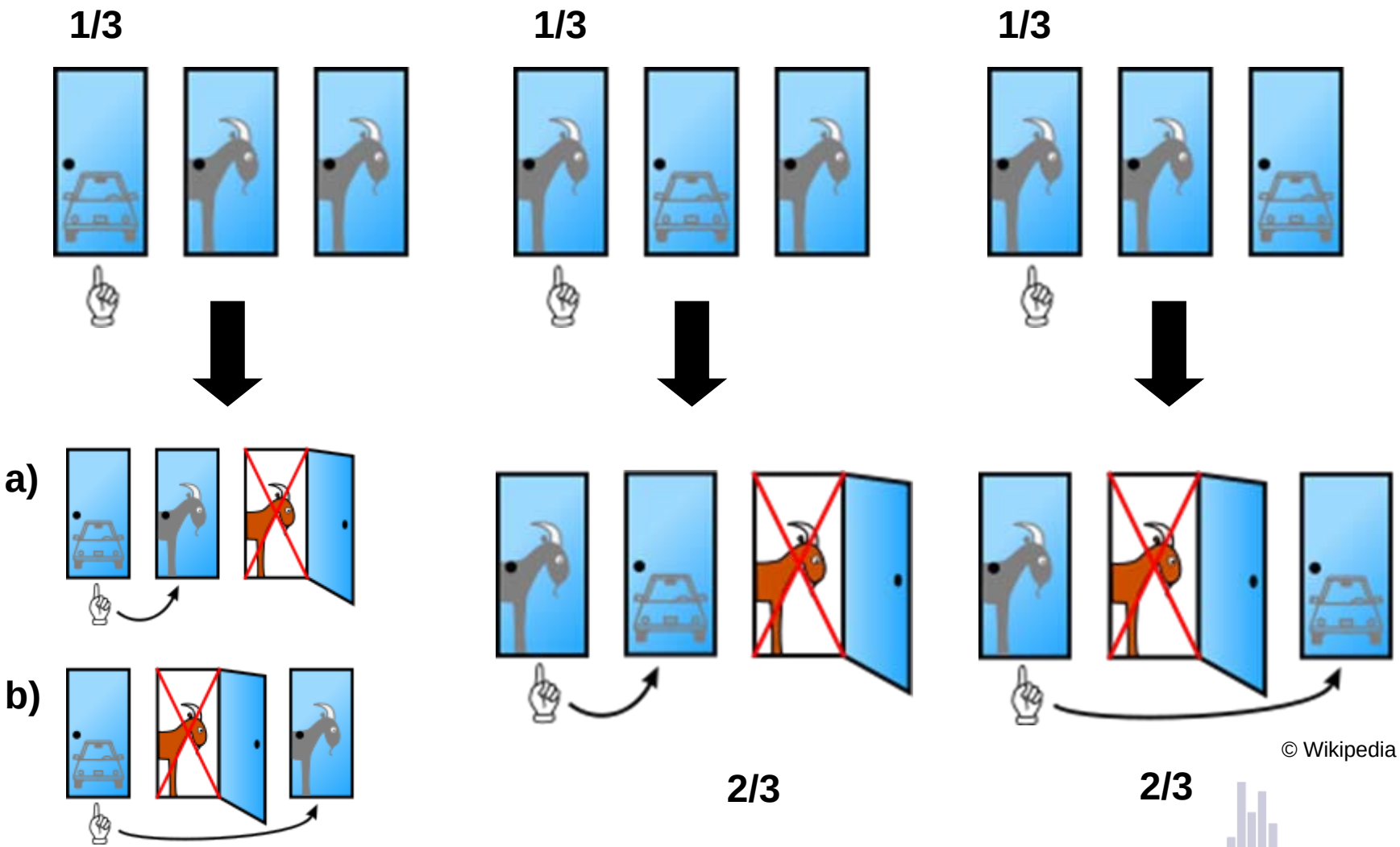
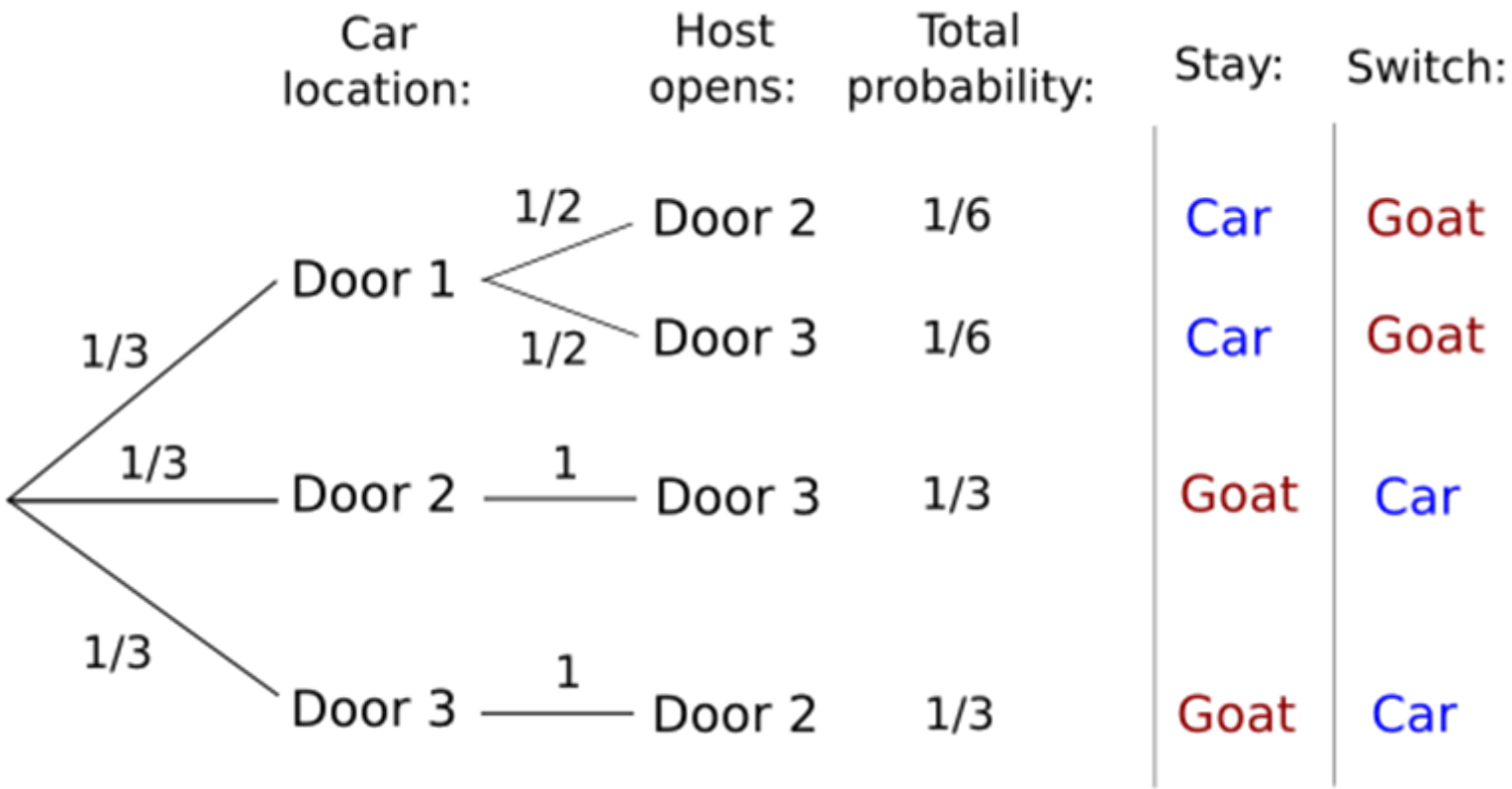
# Lotteries



# Lotteries

## ⊡ Monty Hall Problem

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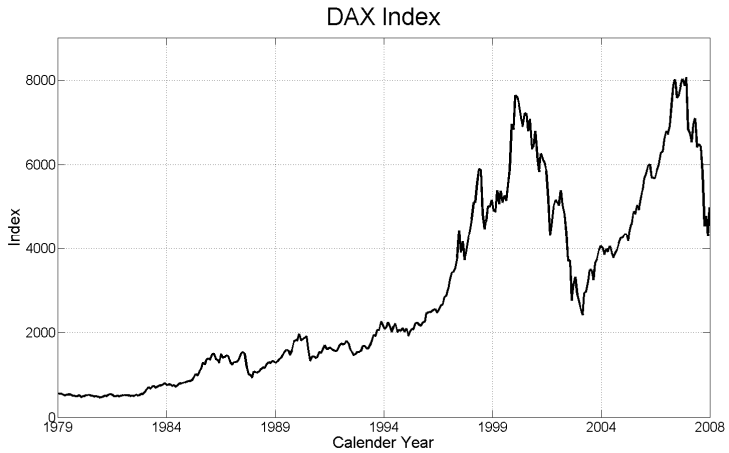
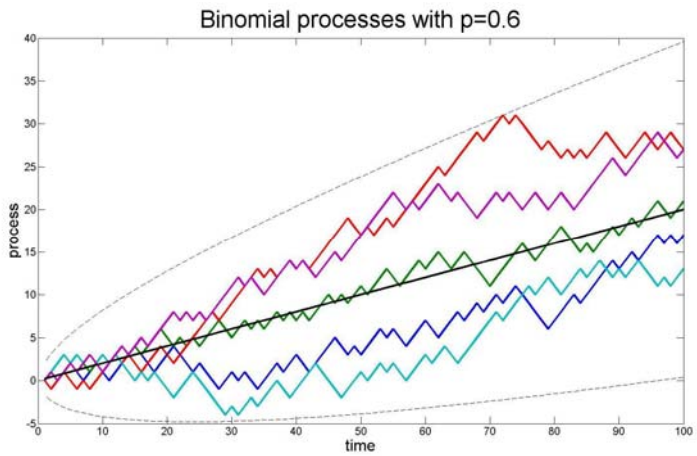
# Measuring Statistical Risk

- Numbers below 31 have lower payment
- Test on uniform distribution (quality control)
- Behavioral Finance (irrational decisions)

# Financial Markets

- How volatile is a portfolio ?
- Risk Management
- Option pricing



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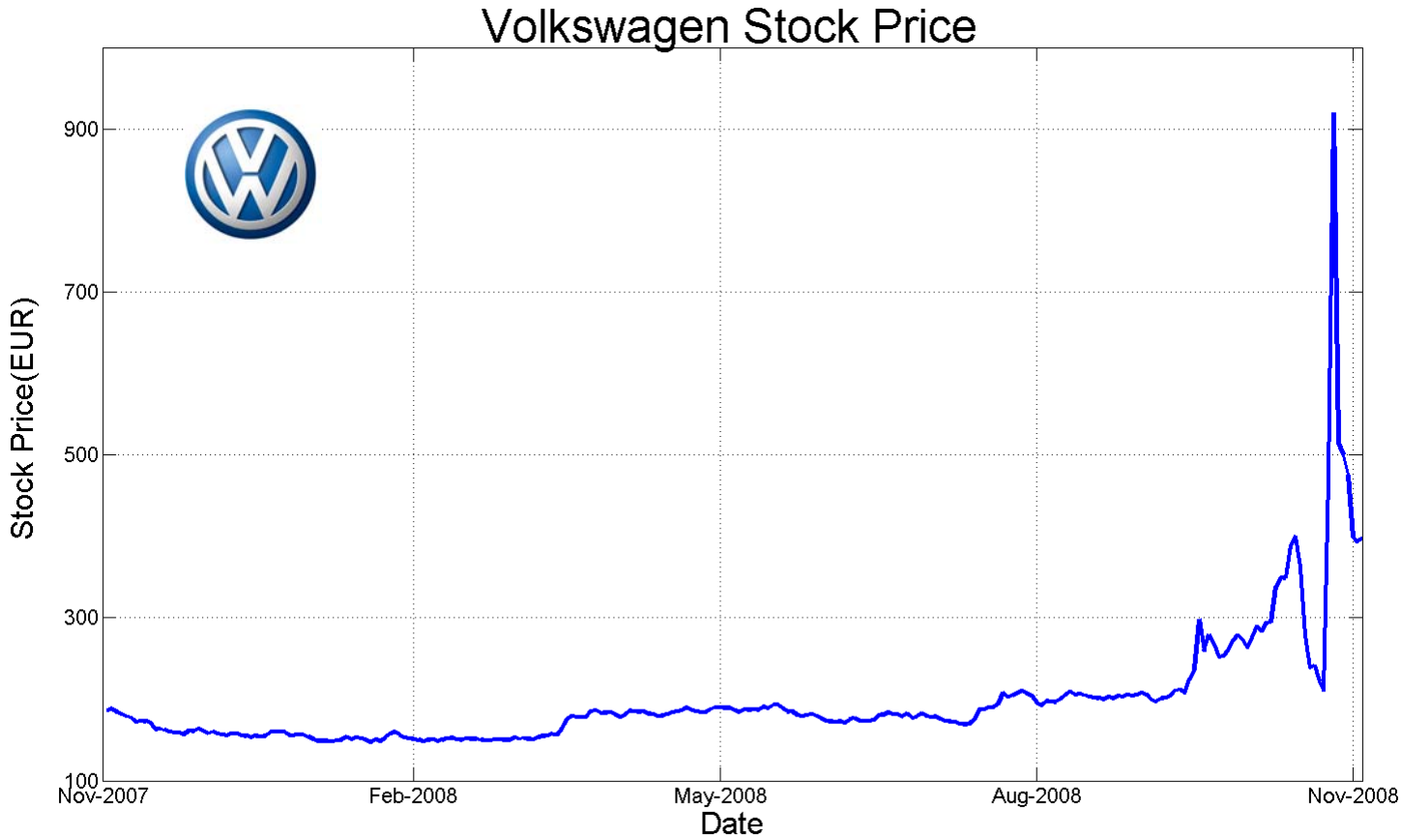
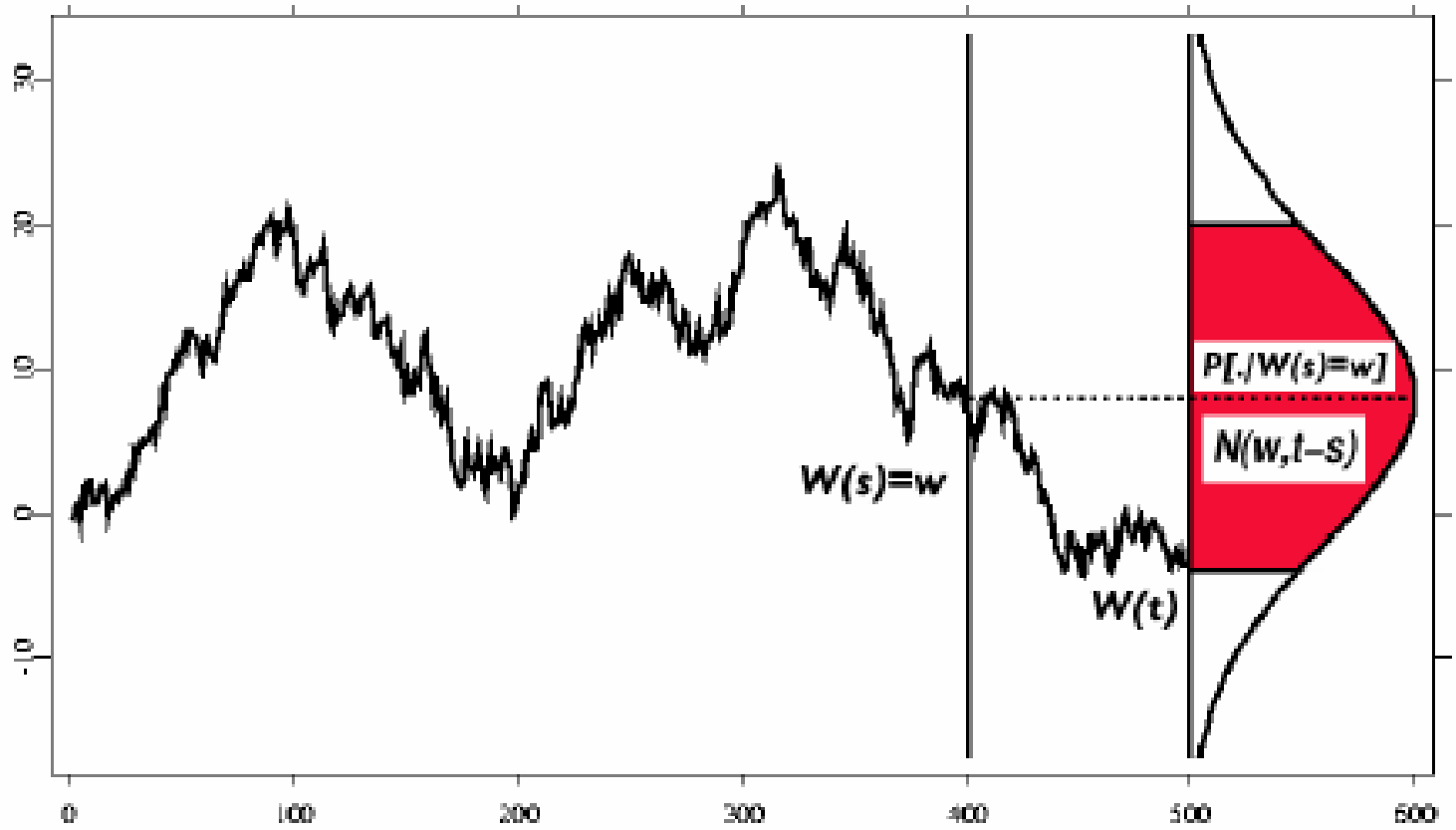
# Financial Markets



# Financial Markets



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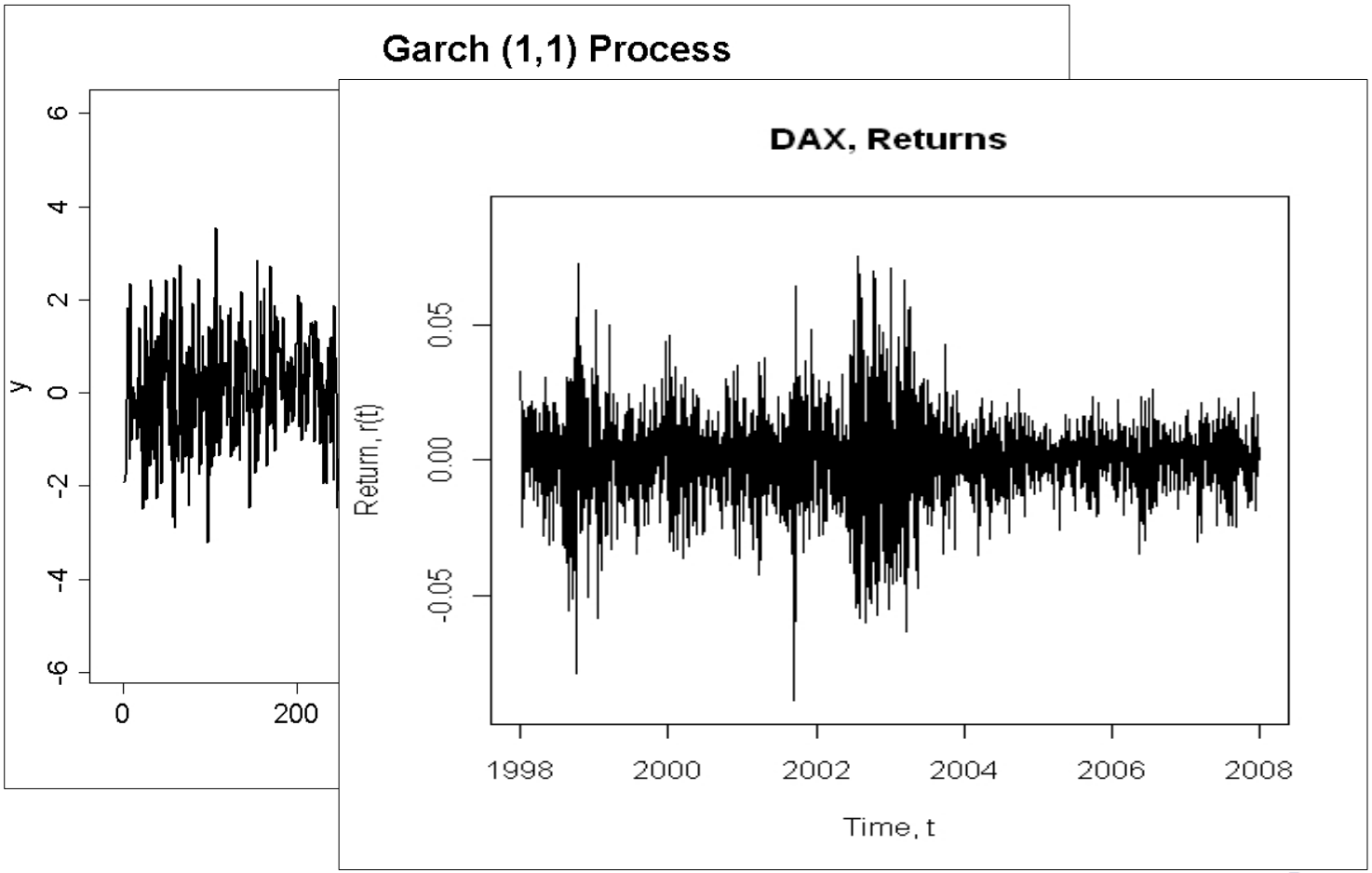
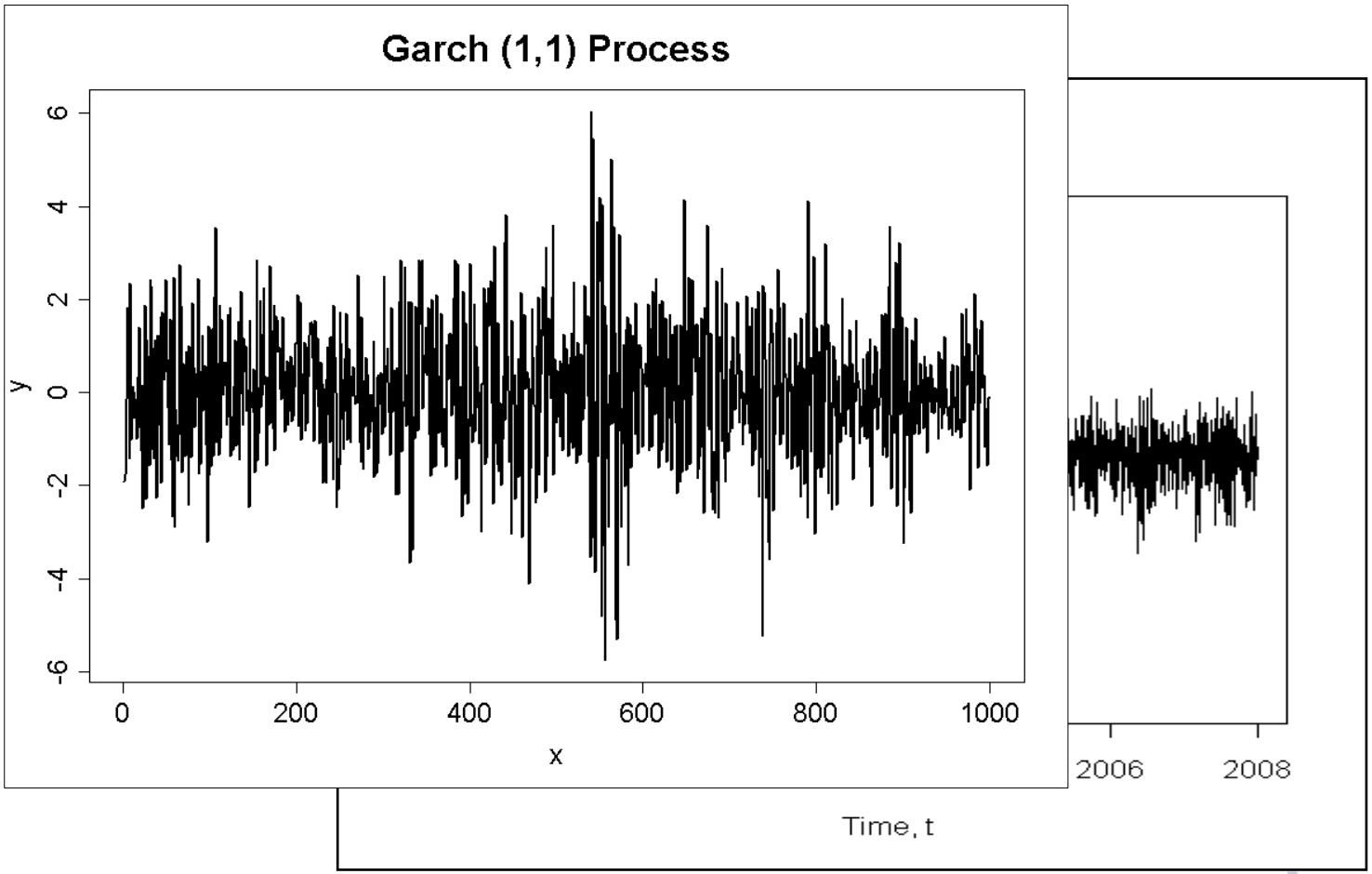
# Financial Markets



# Financial Markets



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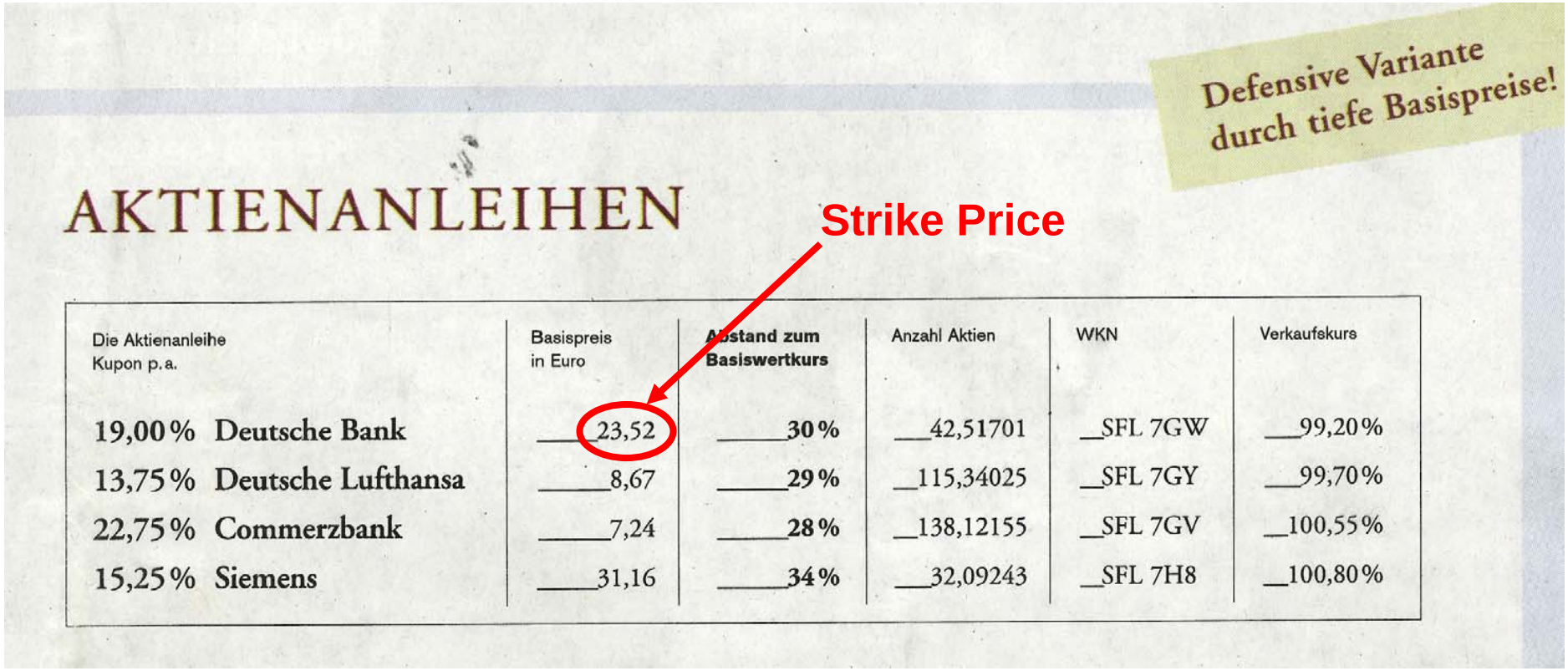


Defensive Variante durch tiefe Basispreise!

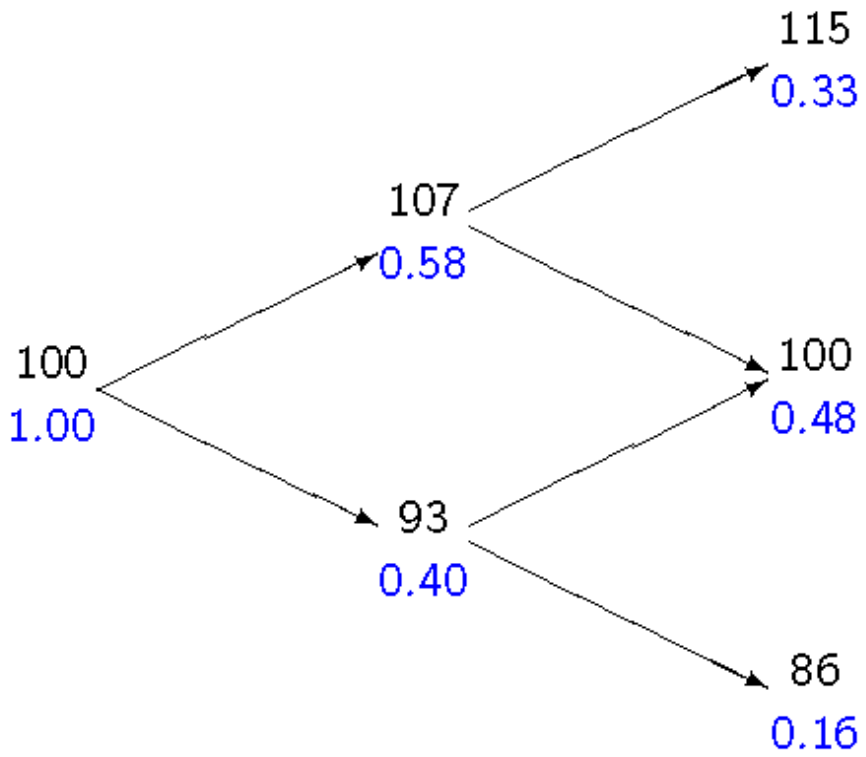
## AKTIENANLEIHEN

Strike Price

| Die Aktienanleihe Kupon p.a. | Basispreis in Euro | Abstand zum Basiswertkurs | Anzahl Aktien | WKN | Verkaufskurs |
|---|---|---|---|---|---|
| 19,00 % Deutsche Bank | 23,52 | 30 % | 42,51701 | SFL 7GW | 99,20 % |
| 13,75 % Deutsche Lufthansa | 8,67 | 29 % | 115,34025 | SFL 7GY | 99,70 % |
| 22,75 % Commerzbank | 7,24 | 28 % | 138,12155 | SFL 7GV | 100,55 % |
| 15,25 % Siemens | 31,16 | 34 % | 32,09243 | SFL 7H8 | 100,80 % |

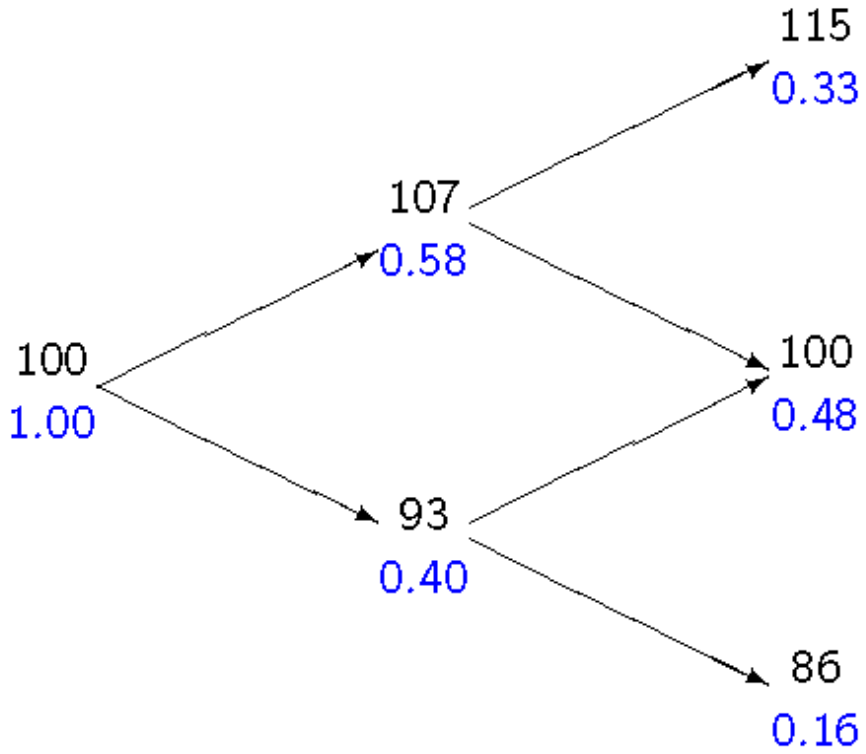
# Financial Markets

- Implied Binomial Tree
- Stock Prices
- Arrow-Debreu Prices
- T=1, n = 2



# Financial Markets

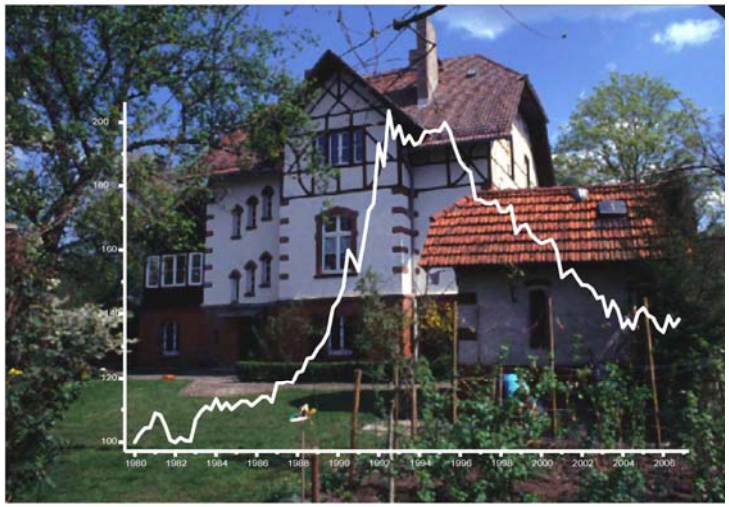
- **Strike Price: 90 EUR**
- **Payoff for a Call option:**




$$C(90,1) = 0.48 \cdot (100 - 90) + 0.33 \cdot (115 - 90) = 13.05$$

# Financial Markets

- Villa in Hirschgarten
- Appartment in Kreuzberg

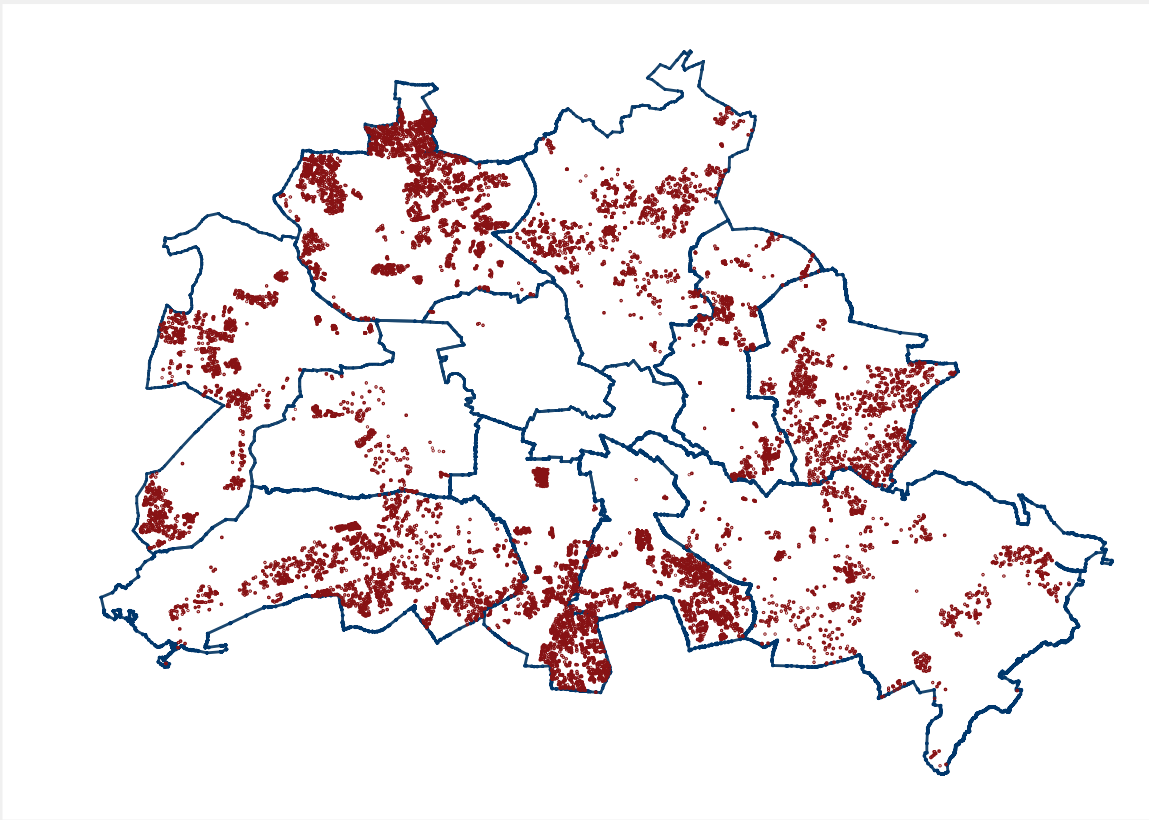



# Real Estate Markets

- Credit Scoring
- Real estate valuation

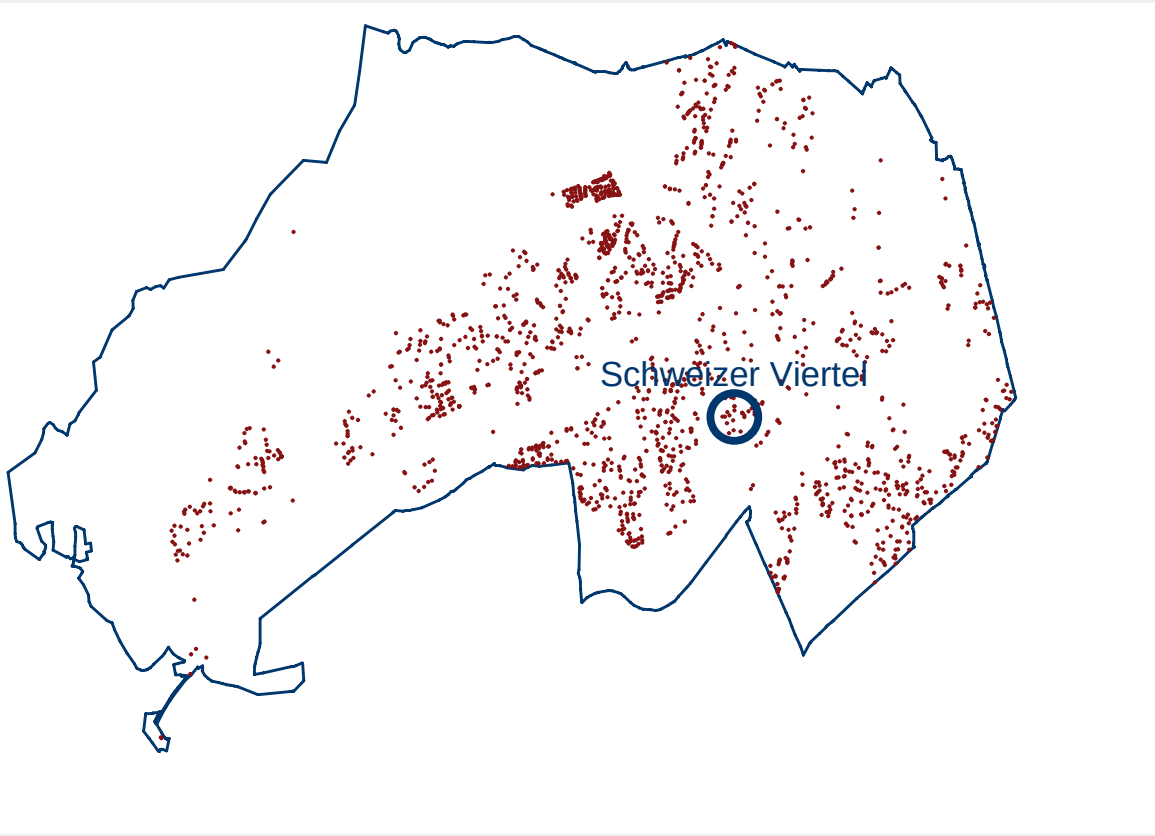
# Real Estate Markets

Berlin



Notes: 14332 Observations (1991q1 - 2007q2).

# Real Estate Markets

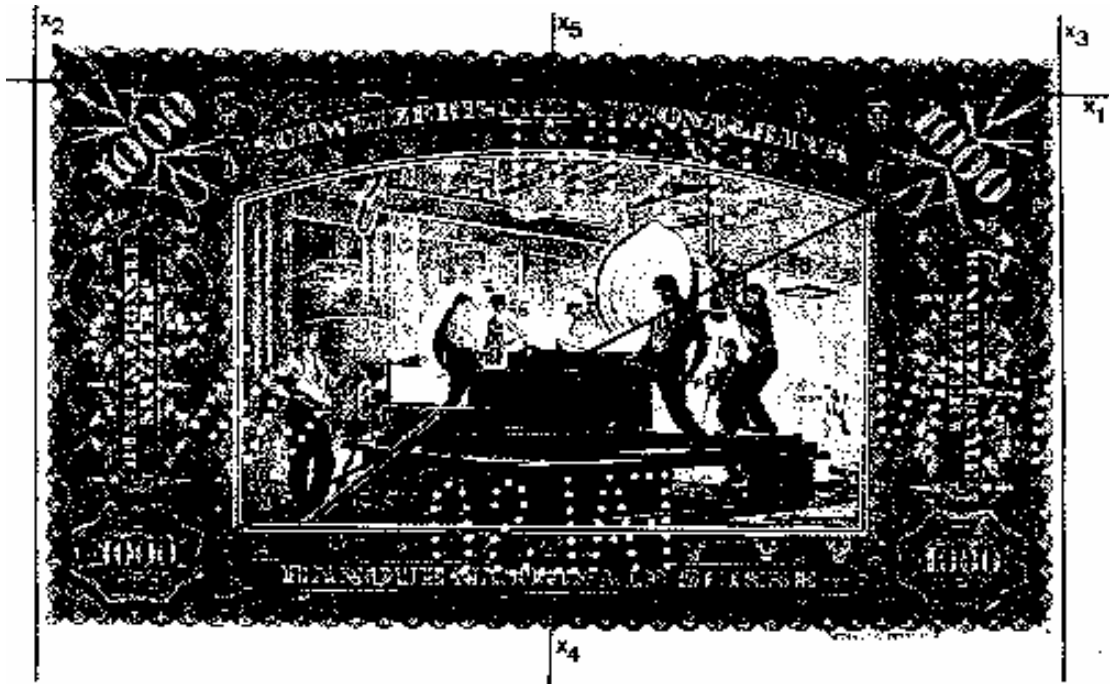



Notes: 1837 Observations (1991q1 - 2007q2).

# Measuring Statistical Risk

- Valuation in the presence of uncertainty
- Volatility prognosis
- Transparency for developers and investors

# Graphical Methods




Forged vs. true old swiss bank notes

# Graphical Methods

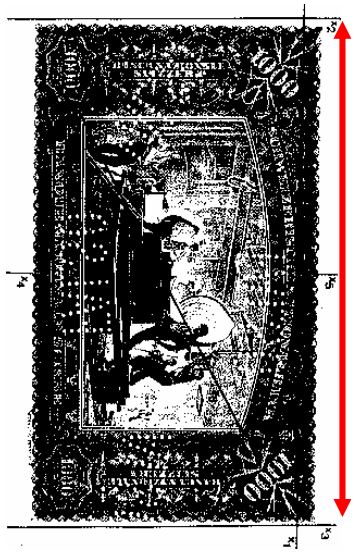
| X1 | X2 | X3 | X4 | X5 | X6 |
|---|---|---|---|---|---|
| 214,5 | 129,5 | 129,3 | 7,4 | 10,7 | 141,5 |
| 214,7 | 129,6 | 129,5 | 8,3 | 10,0 | 142,0 |
| 215,6 | 129,9 | 129,9 | 9,0 | 9,5 | 141,7 |
| 215,0 | 130,4 | 130,3 | 9,1 | 10,2 | 141,1 |
| 214,4 | 129,7 | 129,5 | 8,0 | 10,3 | 141,2 |
| 215,1 | 130,0 | 129,8 | 9,1 | 10,2 | 141,5 |
| 214,7 | 130,0 | 129,4 | 7,8 | 10,0 | 141,2 |
| 214,4 | 130,1 | 130,3 | 9,7 | 11,7 | 139,8 |
| 214,9 | 130,5 | 130,2 | 11,0 | 11,5 | 139,5 |
| 214,9 | 130,3 | 130,1 | 8,7 | 11,7 | 140,2 |
| 215,0 | 130,4 | 130,6 | 9,9 | 10,9 | 140,3 |
| 214,7 | 130,2 | 130,3 | 11,8 | 10,9 | 139,7 |
| 215,0 | 130,2 | 130,2 | 10,6 | 10,7 | 139,9 |
| 215,3 | 130,3 | 130,1 | 9,3 | 12,1 | 140,2 |

**X1** **length**
**X2** **height (left)**
**X3** **height (right)**
**X4** **distance (low)**
**X5** **distance (up)**
**X6** **diagonal**

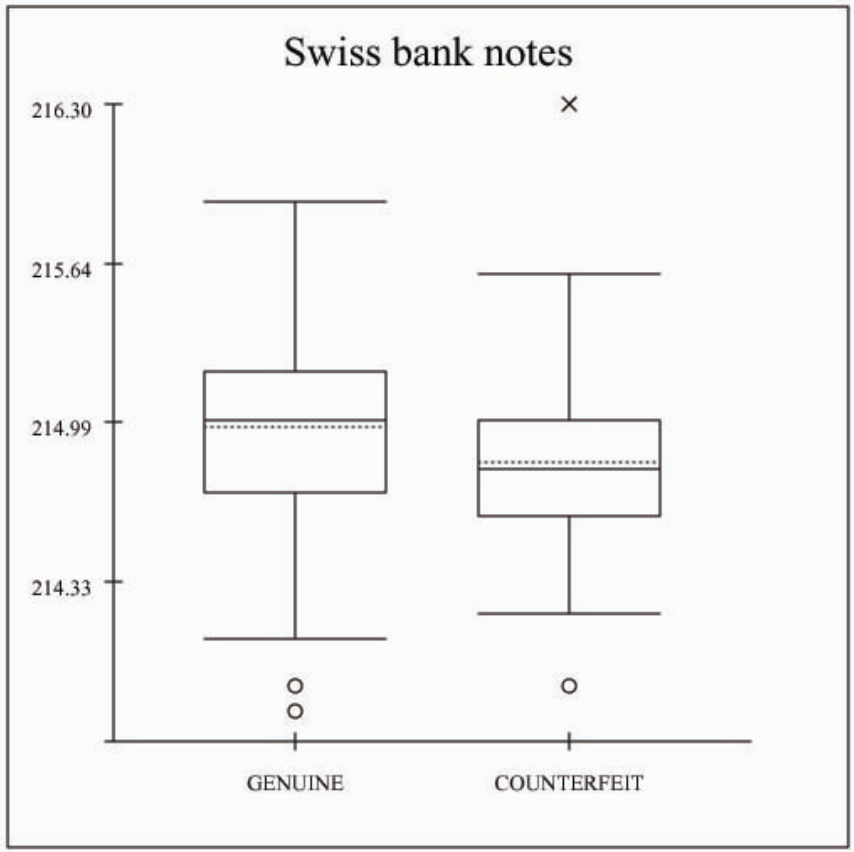
**measured in mm**

# Graphical Methods

- **Boxplots**

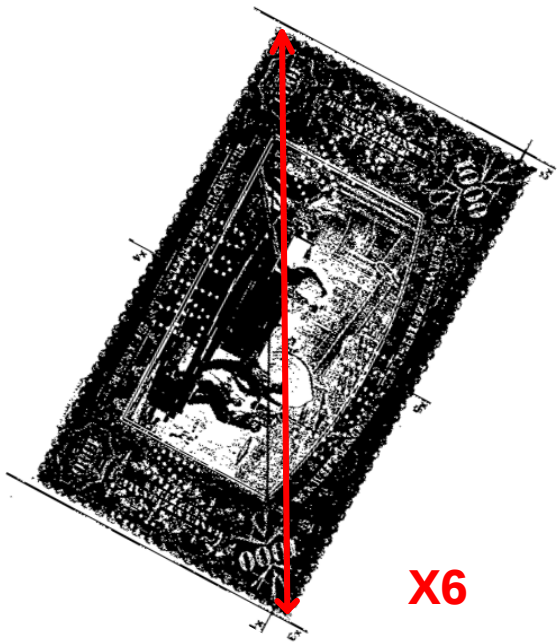


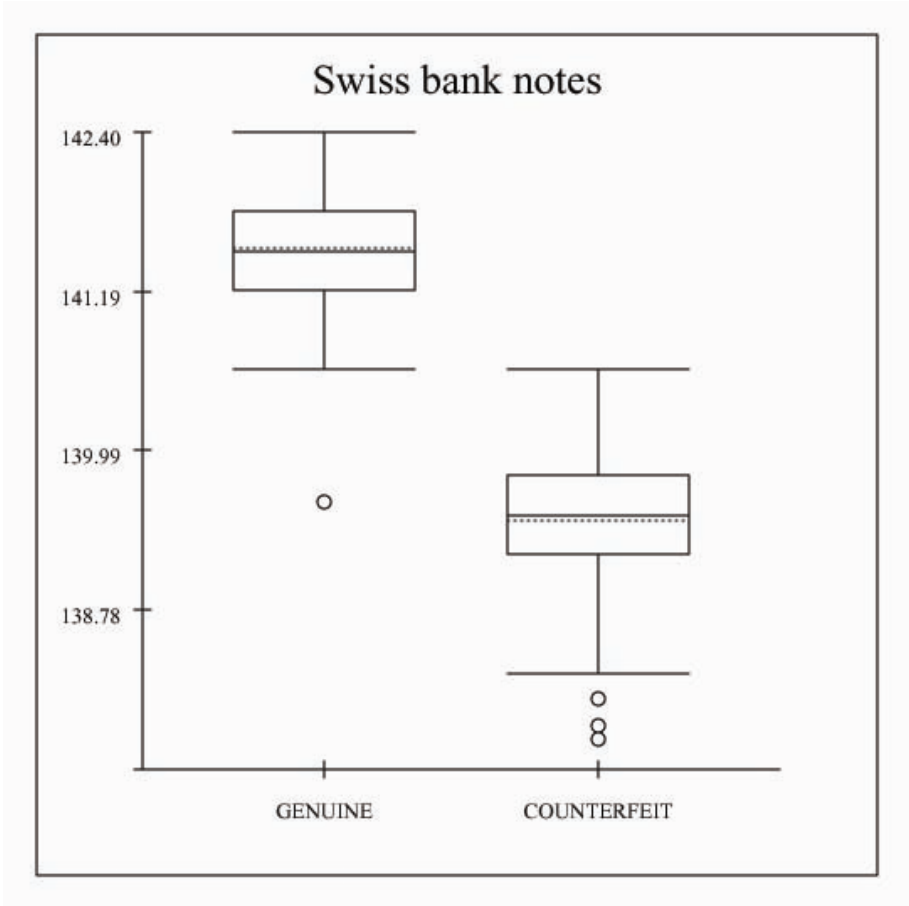
X1



# Graphical Methods

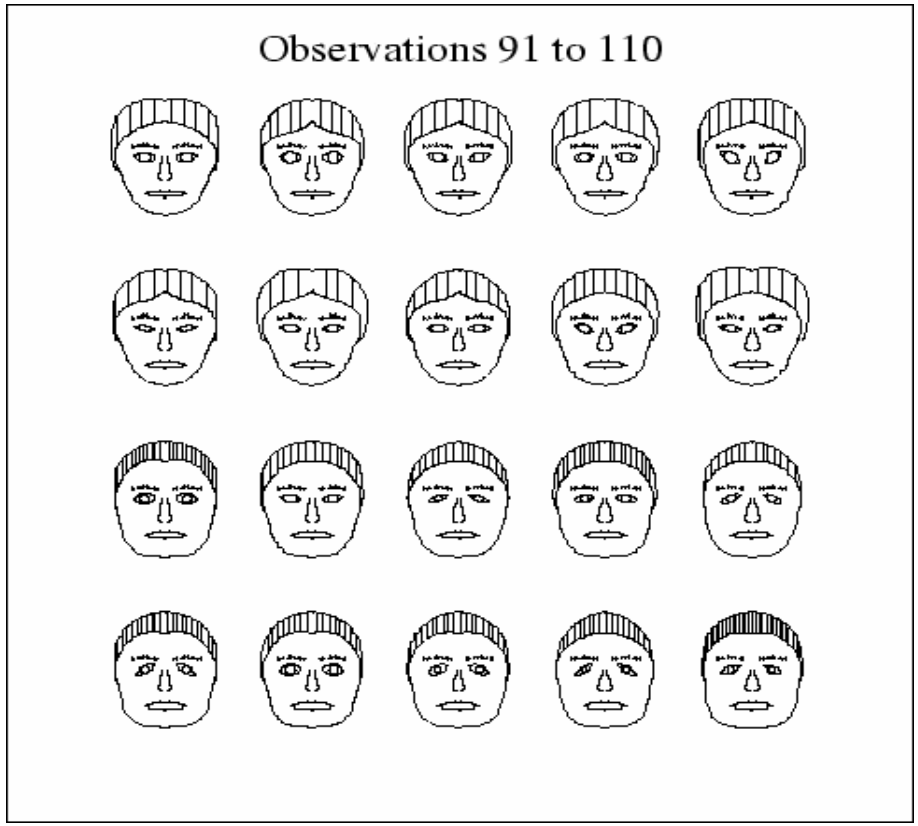
- **Boxplots**



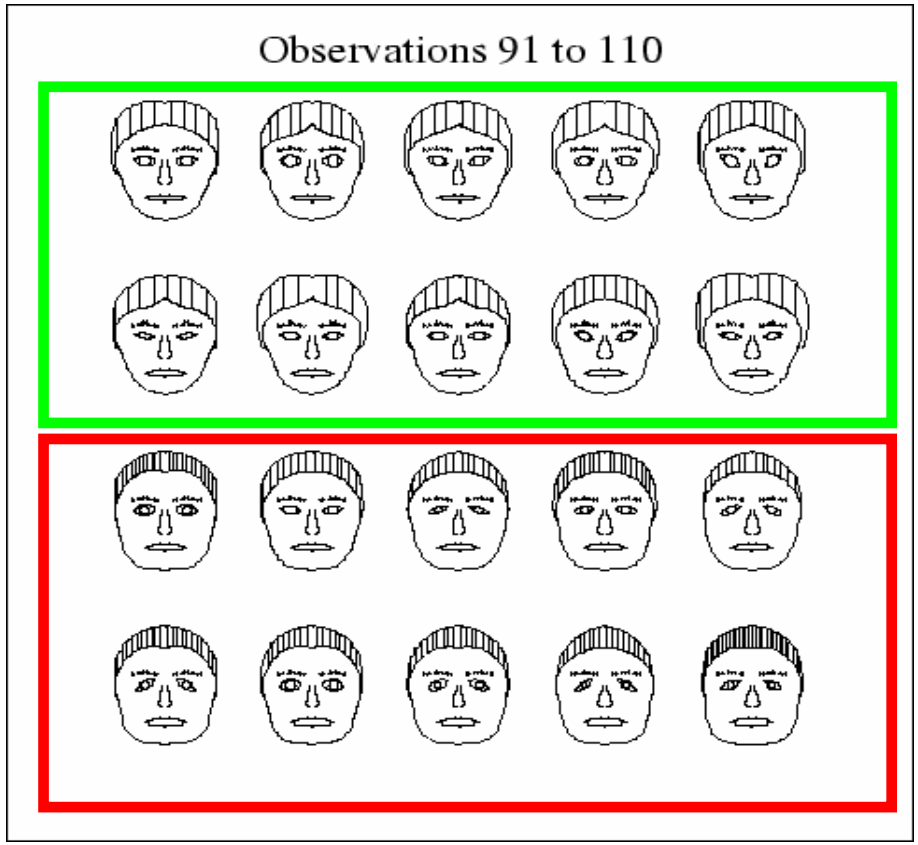
# Graphical Methods

- **Flury-Faces (X1,…, X6)**



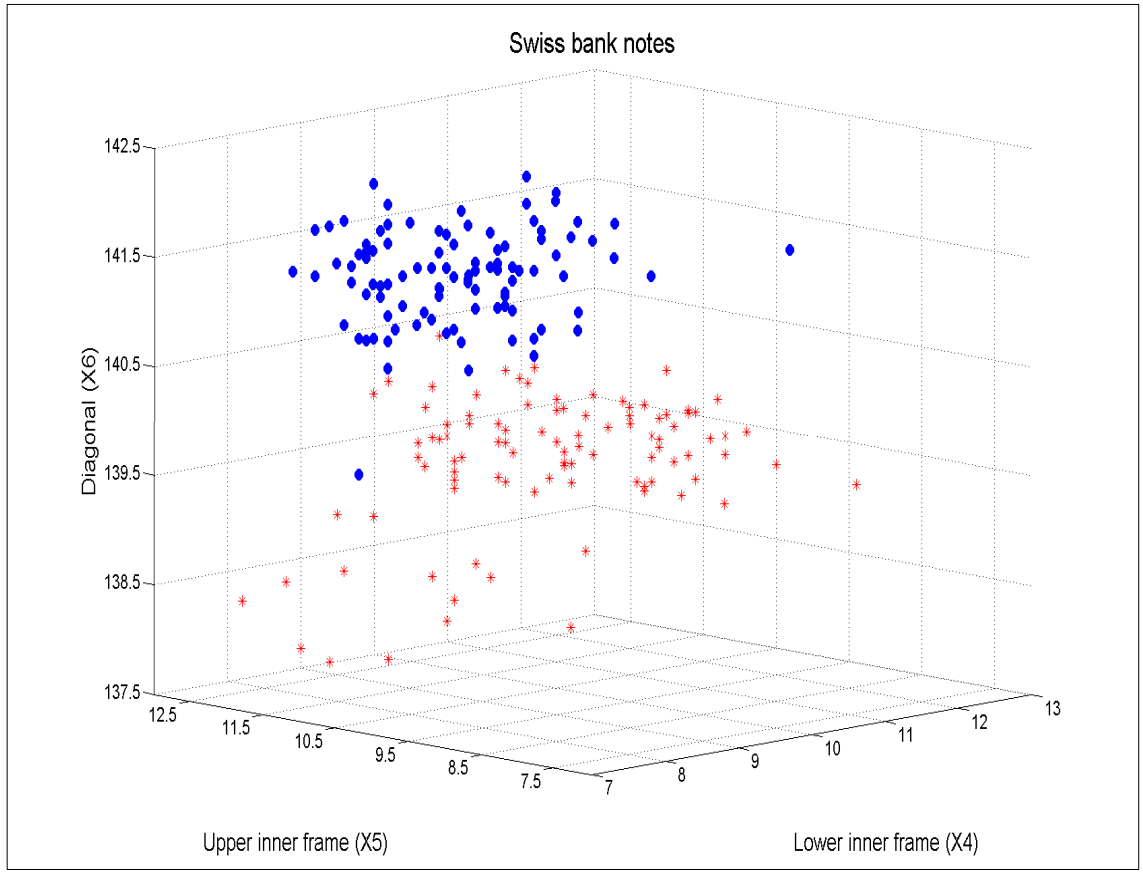
# Graphical Methods

- **Flury-Faces (X1,…, X6)**



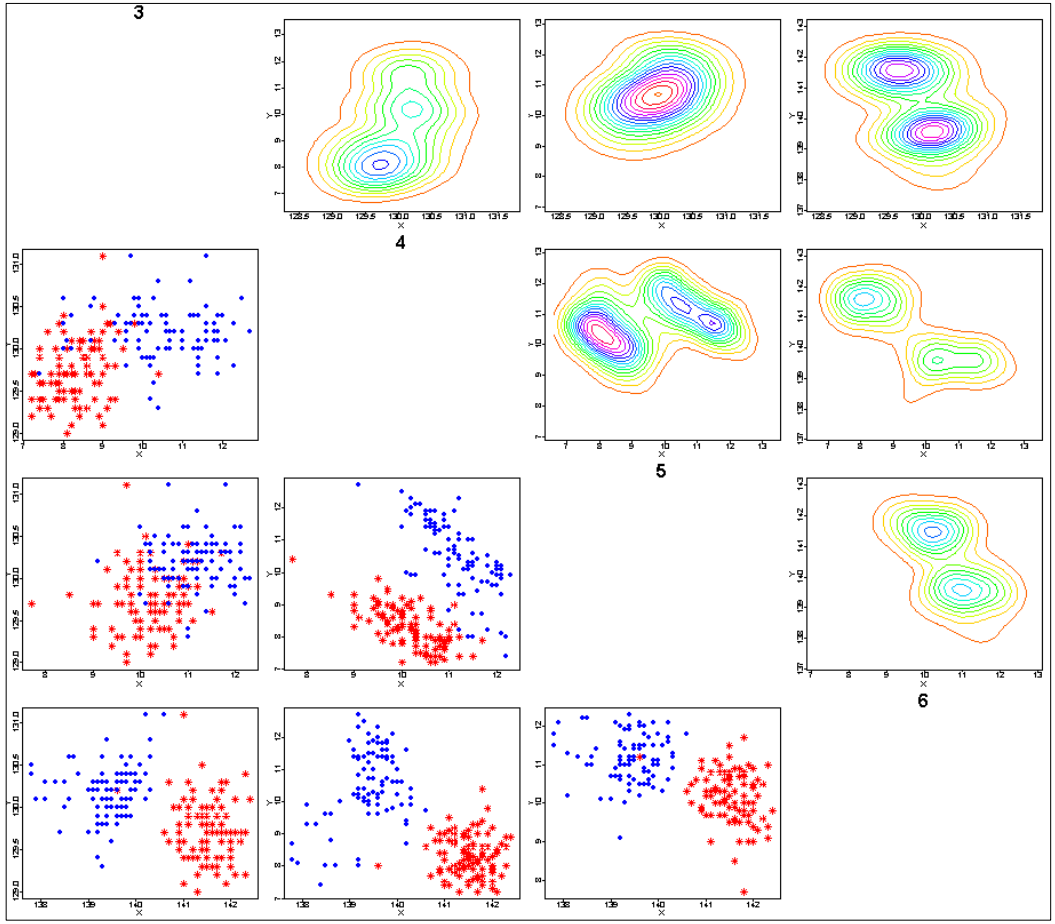
# Graphical Methods

- **3D Scatterplot (X4, X5, X6)**



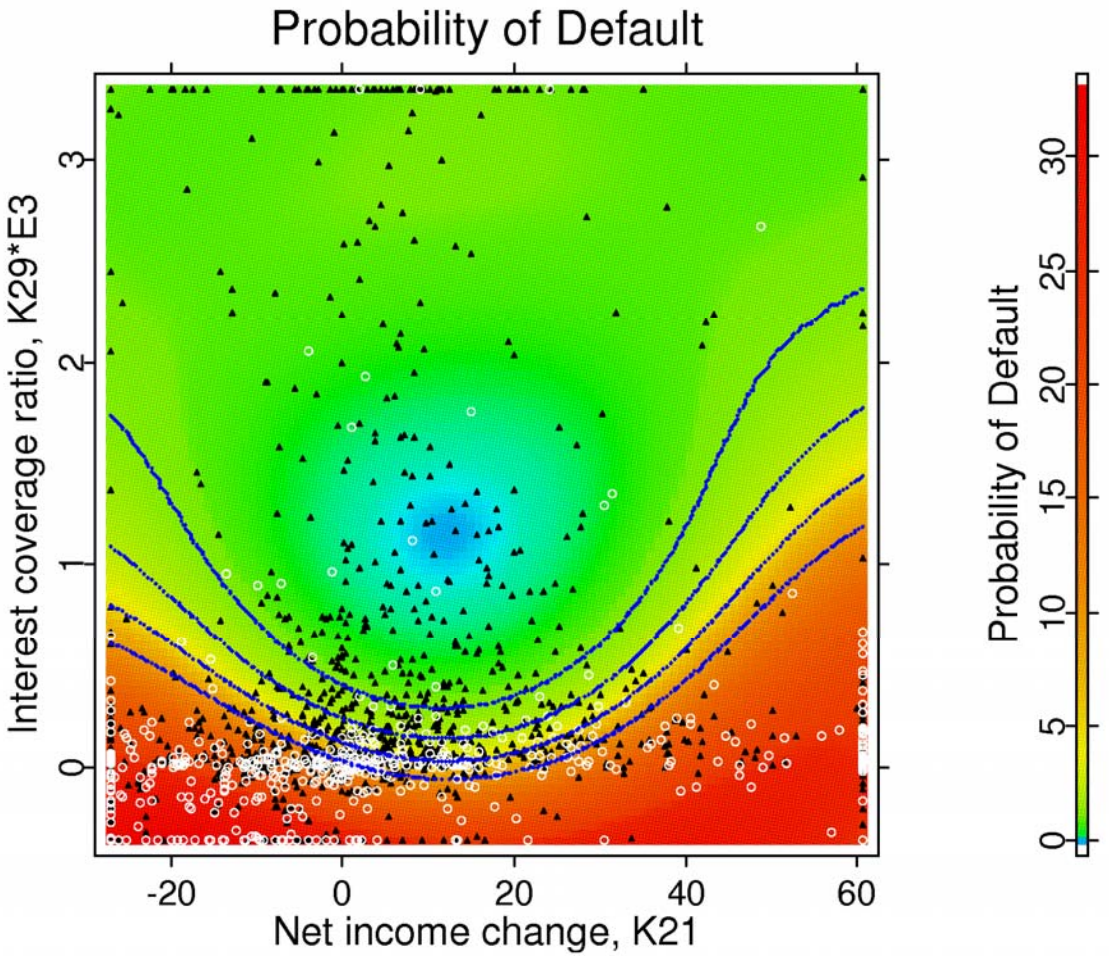
# Graphical Methods

- **Draftman plot (X3, X4, X5, X6)**



# Graphical Methods

- **Support Vector Machines**

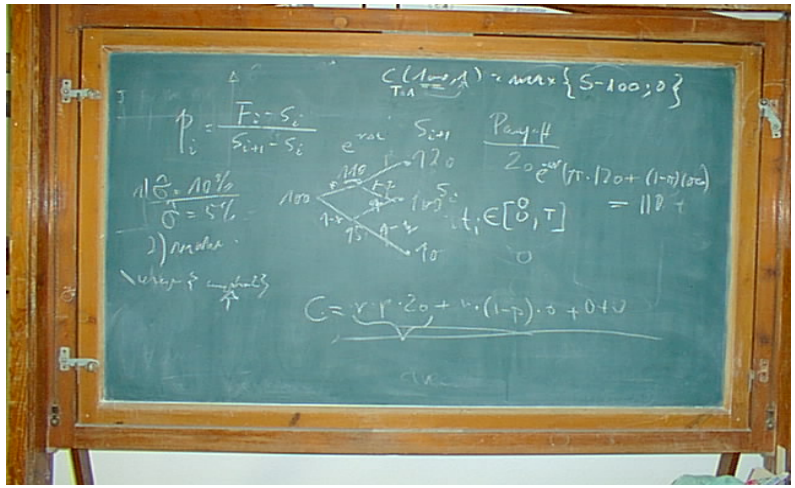


# Measuring Statistical Risk

- Simple and computer intensive methods
- Graphical and numerical procedures
- Static and dynamic presentations

# Conclusion

**May we enjoy**
**our luxurious pensions**
**in well furnished houses**
**in best locations**
**(financed from jackpot hits)**
**and correctly visualize**
**and evaluate our portfolio risks ?**



**Certainly not without a solid statistical risk measurement!**