

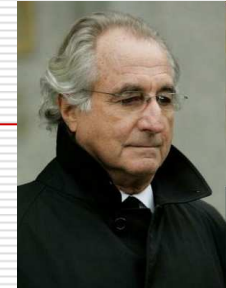
# Statistical challenges in the art market

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Fabian Bocart,  
Y.R.D. 2010

# Who is this man?

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Bernard Madoff, first class criminal

- Plans to take the money, then disappear



Raël, guru of a dangerous sect

- Plans to clone the beefs, then rule the world

John Smith, option trader

- Plans to offset his trades, then go fishing for the weekend



# Who is this man?

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John Smith, option trader



# Option?

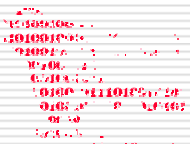
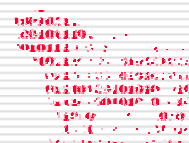
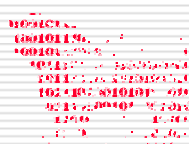
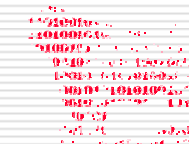
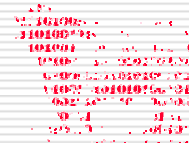
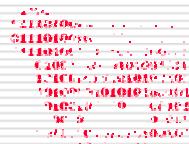
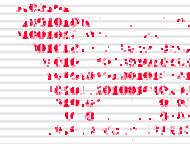
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- The buyer of a call (put) option has the right to buy (sell) a good at a certain price, a certain date.
- The seller of this option must follow the buyer's choice.

# Option?

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- ❑ It is a “right”, not the underlying asset (the beef) that is exchanged.
- ❑ This allows speculators to really inflate the size of a market while trading on totally virtual beefs



# Option price?

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- (almost) entirely defined by the **Expected future volatility of the underlying asset**
- Observed variance of spot price gives some clues on an option's value



Live cattle: spot price

# Let us observe the beef market and compare it to paintings

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## Beefs

- ❑ Sold at auction
- ❑ All goods **similar**
- ❑ Option market gives exposure to price, not to goods. Anyone can be protected against rise in price.
- ❑ Speculation dominates
- ❑ Market is complete

## Paintings

- ❑ Sold at auction
- ❑ All paintings **different**
- ❑ No option market, one has to buy/sell paintings to be exposed to price.
- ❑ Consumption dominates
- ❑ Market is incomplete

# Main problem: heterogeneity

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*Bull with glass*  
Pablo Picasso  
1958  
Private Collection

**In art,  
one beef  
is not  
another**



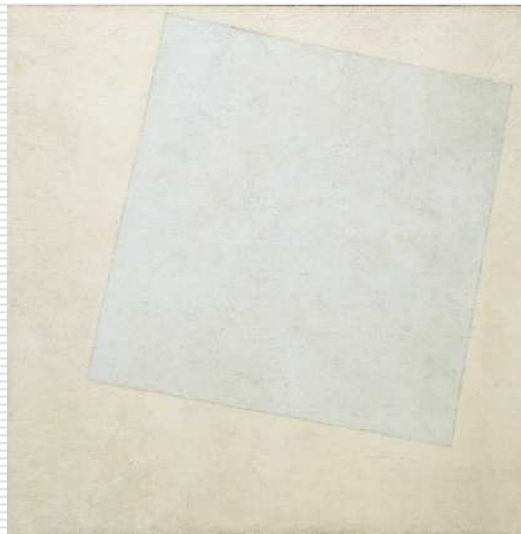
*The carcass of beef*  
Rembrandt  
XVIIth century  
Le Louvre, Paris



# Main problem: heterogeneity

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- How to track price through time?
  - Idea: decompose prices to get rid of idiosyncratic characteristics → regression



*"White square on white background"*  
*Kazimir Malevich*  
*1918*  
*MoMA, New York*

# Linear model: main idea

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$$Y = X\beta + \epsilon$$

$$\beta = (\beta_{t_1}, \beta_{t_2}, \dots, \beta_{t_T}, \beta_{i_1}, \dots, \beta_{i_S})'$$

Y is the logged price

X is the matrix of exogenous variables: time dummies, size, artist,...

There are T time dummies and S other explanatory variables.

Epsilon is an error term

Betas are coefficients of the variables

The return is computed using exclusively the beta coefficients linked to the **time dummies**.

$$r_{t_{k+1}} = e^{(\beta_{t_{k+1}} - \beta_{t_k})} - 1$$

# Estimation of the Betas

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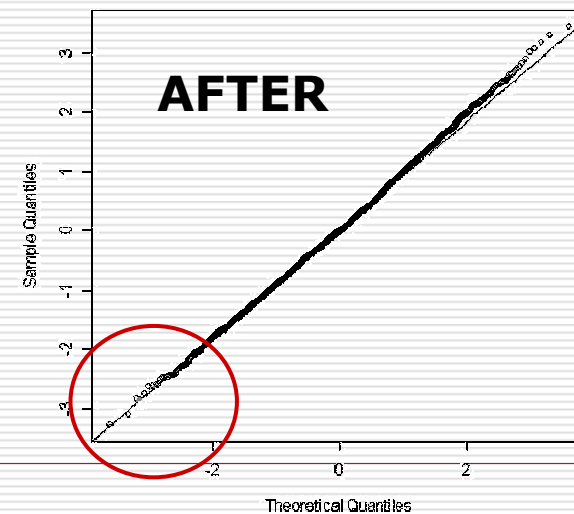
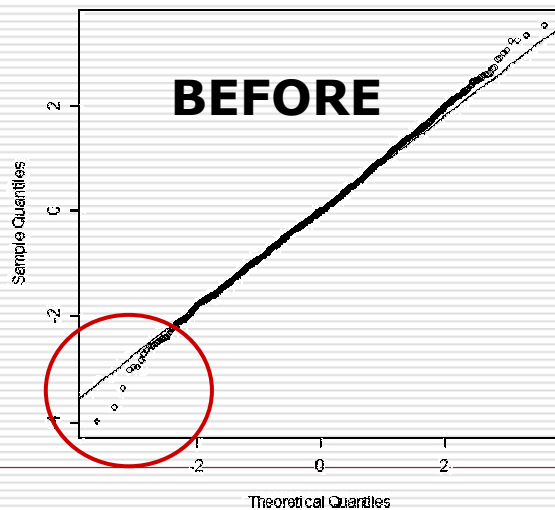
- Originally: Ordinary Least Squares
  - Problems:
    - Assumption: Normality of the residuals
    - What to do when a painting is brought at auction but unsold (price is zero)?
    - For computing returns: scarcity of the data through time
    - ...

# Statistical challenges

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## □ Normality assumption

- Hodgson and Vorkink(2004) suggest using a semi-parametric method: Bickel (1982)'s adaptive estimation
  - Waives the normality assumption
  - Remaining assumption: symmetry of the residuals.
  - Betas are consistent and asymptotically normal



# Statistical challenges

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- What happens if a painting is **not** sold ?
  - Bias in the sample
  - Zanola, Collins and Scorcu(2009) suggest using "***Heckman's procedure***"

$$Y | p > 0 = X\beta + \psi f(X^*) + \epsilon$$

- One introduces a term that takes into account the probability to sell the piece.
- The error term is supposed to follow a normal distribution

# Statistical challenges

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- PhD project:
  - Part I
    - Designing a new index
    - Improving exogenous variables
  
  - Part II
    - Designing an estimator of volatility
    - Study volatility co-movements
  
  - Part III
    - Pricing insurance products

# Designing a new index

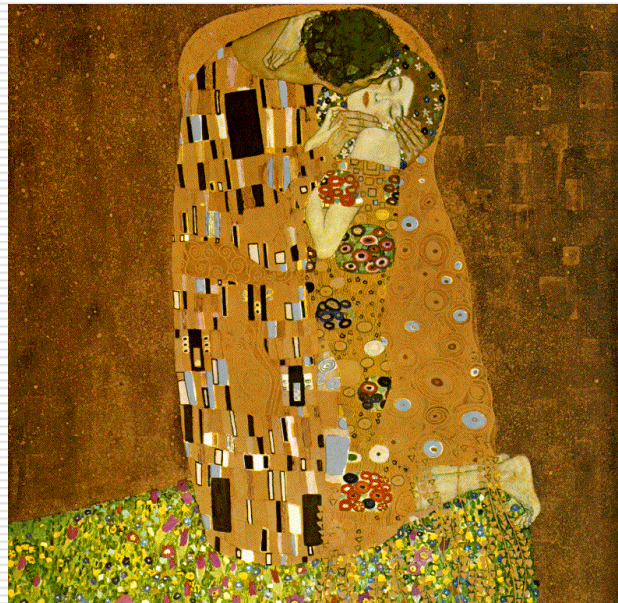
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- Merging Heckman's procedure with Hodgson and Vorkink(2004)
  - First: Try to apply directly adaptive estimation to output of Heckman's procedure.
  - If poor results: implement Heckman's Fisher information matrix into adaptive estimation procedure.

# Improving exogenous variables

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- A painting is more than a description
  - Introduce image-related information (colors, shapes, etc.) into the regression. Suggested tool: Wavelets



*The Kiss*  
*Gustav Klimt*  
*1907*  
*Österreichische Galerie*  
*Belvedere*



# Estimator of volatility

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- The index is built, not observed
  - Estimator should take uncertainty of the model into account
- Direct applications:
  - Value options on artworks
  - Study volatility co-movement with other markets

# Insurance products

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- ❑ Forgeries exist but cannot be insured
- ❑ Tracking of volatility could allow better forecast of reserves
- ❑ Other challenges linked to forgeries: contagion, fraud, expert opinion etc.

# Conclusion

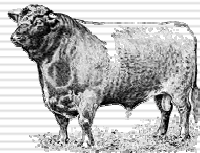
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- ❑ Art market underdeveloped as compared to other commodities: heterogeneity is the main issue
- ❑ OLS allows to estimate returns, build index
- ❑ Adaptive estimation + heckman procedure would fix remaining issues
- ❑ Image analysis could improve quality of indices
- ❑ Precise estimation of variance could lead to new financial and insurance products on art as a commodity

# Option?

- The day the option expires, as the price fixed in the option contract differs from the one of "real" beefs, cash is exchanged
- Still, some "open contracts" lead to delivery (McDo)
- Delivery is cleared by the exchange

3000\$



3000\$

3000\$

2000\$

→ 1000\$ exchanged



2000\$

3300\$

→ 0\$ exchanged

500\$

→ 2500\$ exchanged

→ 2000\$ exchanged + Delivery

