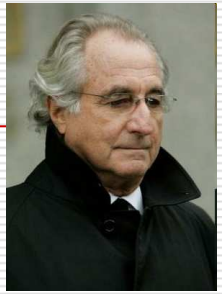
Statistical challenges in the art market

Fabian Bocart,

Y.R.D. 2010

Who is this man?



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?

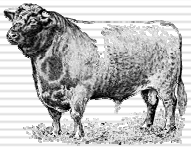
John Smith, option trader

Option?

- 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?

- 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?

- (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

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

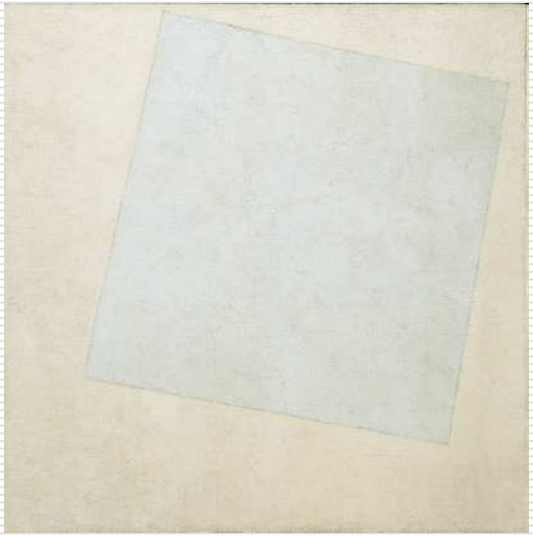
Bull with glass
Pablo Picasso
1958
Private Collection

In art, one beef is not another

The carcass of beef
Rembrandt
XVIIth century
Le Louvre, Paris

Main problem: heterogeneity

- 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

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

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

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**.

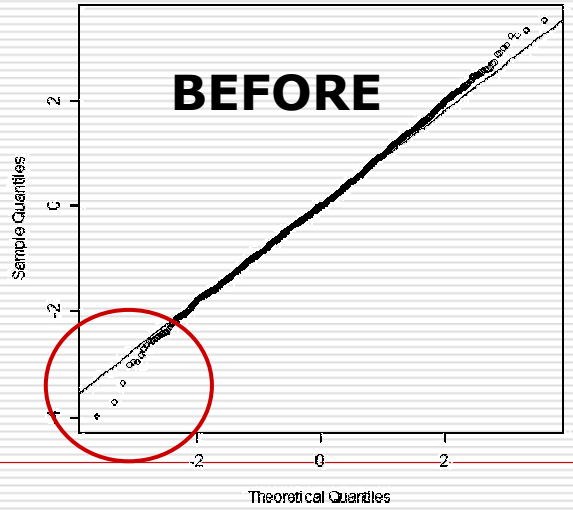
$$r_{t_{k+1}} = e^{(\beta_{t_{k+1}} - \beta_{t_k})} - 1$$

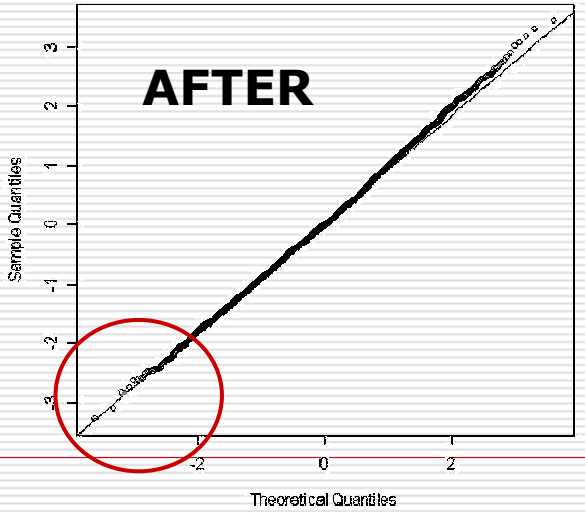
Estimation of the Betas

- 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

- 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

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

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

  - 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

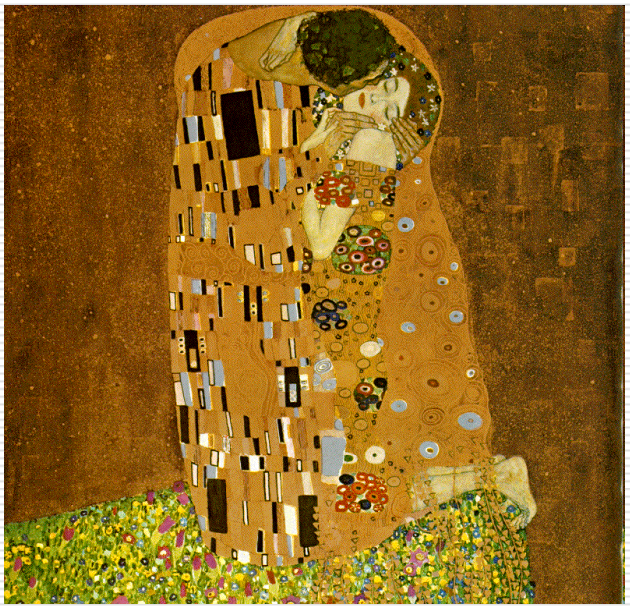
- PhD project:
  - Part I
    - Designing a new index
    - Improving exogenous variables
  - Part II
    - Designing an estimator of volatility
    - Study volatility co-movements
  - Part III
    - Pricing insurance products

Designing a new index

- 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

- 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

- 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

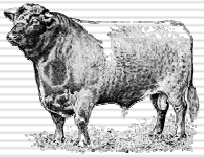
- Forgeries exist but cannot be insured
- Tracking of volatility could allow better forecast of reserves
- Other challenges linked to forgeries: contagion, fraud, expert opinion etc.

Conclusion

- 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$ 

2000$:
→ 1000$ exchanged

3300$
→ 0$ exchanged

500$
→ 2500$ exchanged

2000$
→ 2000$ exchanged + Delivery

CBOT