

S.A.I.V.I.M.: THE PROBABILISTIC PROCEDURE FOR MARKET ABUSES DETECTION

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SAIVIM – THE CONSOB PROCEDURE FOR THE MARKET ABUSE DETECTION

SYLLABUS

- **PRELIMINARIES ON MARKET ABUSE DETECTION**
- **CONSTRUCTION OF THE MARKET ABUSE DETECTION PROCEDURE**
- **EMPIRICAL RESULTS**

MARKET ABUSES



THE PROBLEM FOR THE SUPERVISORY AUTHORITIES

IS:

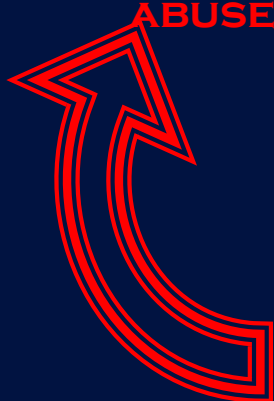
THE REAL TIME IDENTIFICATION OF
MARKET ABUSE PHENOMENA



MARKET ABUSE DETECTION

...THAT'S BECAUSE...

ACTIONS WHICH MAY BE
ATTRIBUTED TO MARKET
ABUSE PHENOMENA



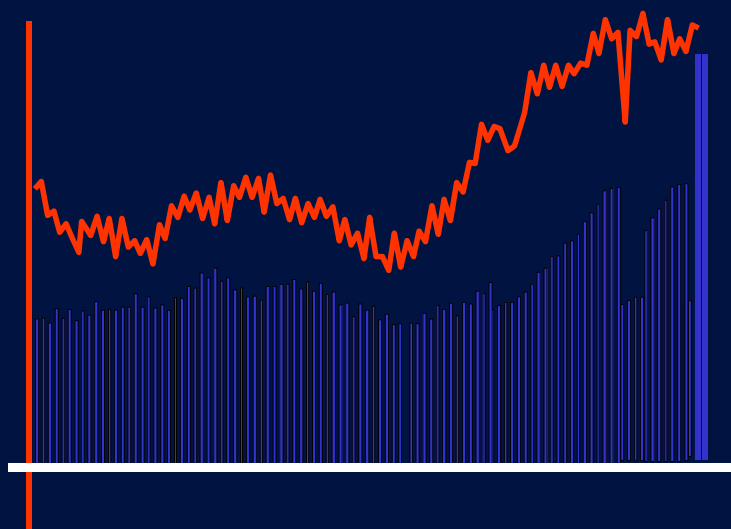
PARTICULAR
OCCURRENCE/
EVENT REFERRED
TO A SPECIFIC
STOCK



FAILURE



HOW TO DETECT A FAILURE?
THROUGH THE EXAM OF THE ELEMENTARY
COMPONENTS WHICH MAINLY AFFECT THE
PATTERN OF
A STOCK AND
WHICH
CHARACTERISE
THE TRADES
MADE BY THE
INTERMEDIARIES



THE ELEMENTARY COMPONENTS:



HOW TO **EXAMINE** THE ELEMENTARY COMPONENTS IN ORDER TO DETECT A FAILURE?

THE FINANCIAL LITERATURE

THE SUPERVISORY EXPERIENCE



QUANTITATIVE MODELS

PRICES

THE FINANCIAL LITERATURE

- THE TRADING PRICES HAVE TO BE ANALYSED IN TERMS OF RETURNS, THROUGH THE STUDY OF THE DYNAMICS OF THE LOGARITHM OF THE PRICE;
- AUTO-REGRESSIVE MODELS IN DISCRETE TIME CAPTURE BOTH THE MEAN REVERSION AND THE MOMENTUM EFFECT COMPONENTS OF THE RETURNS;
- THE PRESENCE OF ABNORMAL RETURNS IS DISCLOSED THROUGH AN ESTIMATION OF THE RETURNS WHICH MAY BE REALISED EMPLOYING DIFFUSIVE PROCESSES

THE SUPERVISORY EXPERIENCE

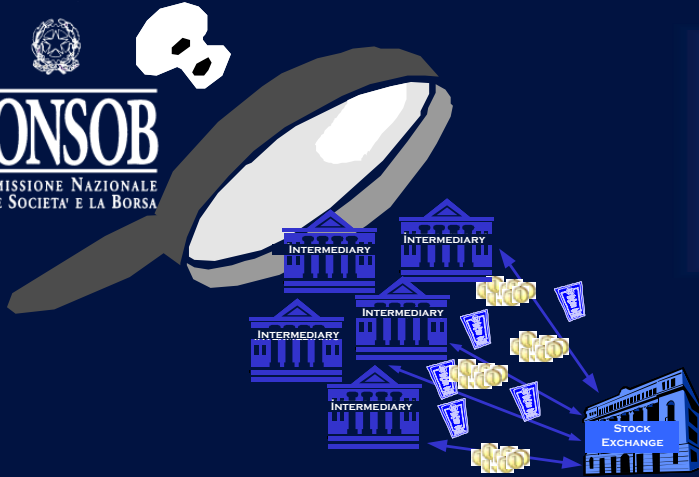
- STOCK RETURNS GENERALLY UNDERGO SHARP CHANGES (FOR EXAMPLE AT MOMENT INSIDER INFORMATION IS DISCLOSED) OR SHOW MOVEMENTS THAT CANNOT BE ATTRIBUTED TO A MEAN-REVERTING TYPE DYNAMIC (FOR EXAMPLE IN THE PRESENCE OF MANIPULATION);

QUANTITIES

THE FINANCIAL LITERATURE AND THE SUPERVISORY EXPERIENCE

- THE QUANTITIES TRADED BY EACH INTERMEDIARY ARE EXAMINED IN AN AGGREGATE WAY IN TERMS OF DAILY TRADING VOLUMES ACCORDING TO AN AUTO-GRESSIVE SCHEME
- THE MARKET COMPOSITION IS ASSESSED THROUGH TWO LEVELS OF ANALYSIS:
 - THE LEVEL OF CONCENTRATION OF THE INTERMEDIARIES, THAT IS THE NUMBER OF INTERMEDIARIES AND THEIR SHARES IN TERMS OF TRADING VOLUMES (SO-CALLED **STATIC CONCENTRATION**);
 - THE EVOLUTION OF THE CONCENTRATION OF THE INTERMEDIARIES, THAT IS THE CHANGE OF EACH INTERMEDIARY'S SHARE IN TERMS OF TRADING VOLUMES ON A GIVEN SECURITY (SO-CALLED **DYNAMIC CONCENTRATION**).

...HENCE, A MARKET ABUSE DETECTION PROCEDURE ...



...REQUIRES THE CONTROL OF 4 FINANCIAL VARIABLES:

- PRICES
- VOLUMES
- STATIC CONCENTRATION
- DYNAMIC CONCENTRATION



THE ALERTS' GENERATION

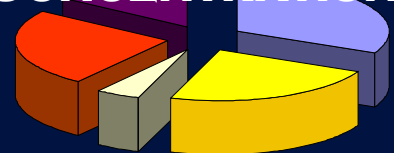
QUANTITIES



PRICES



STATIC AND DYNAMIC CONCENTRATION



A background of various mathematical formulas, including:

$$dX = q(\mu - X_t)dt + \sigma dW_t$$

$$P\left(\mu - z_{\frac{\sigma}{2}}\sqrt{\frac{\sigma^2}{2q}}(1 - e^{-2q}) + (X_t - \mu)e^{-q} \leq X_{t+1} \leq \mu + z_{\frac{\sigma}{2}}\sqrt{\frac{\sigma^2}{2q}}(1 - e^{-2q}) + (X_t - \mu)e^{-q}\right)$$

$$M(t)_k = \gamma + \phi \lambda (t - h)_k + \varepsilon(t)$$

$$dX_{k-1} = q(\mu - X_{k-1})dt + \sigma dW_{k-1}$$

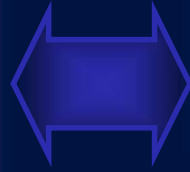
$$X_{k-1} = (1 - e^{-q})\int_0^t q(\mu - X_{k-1})dt + \sigma W_{k-1}$$

$$P\left(\mu - z_{\frac{\sigma}{2}}\sqrt{\frac{\sigma^2}{2q}}(1 - e^{-2q}) + (X_{k-1} - \mu)e^{-q} \leq X_k \leq \mu + z_{\frac{\sigma}{2}}\sqrt{\frac{\sigma^2}{2q}}(1 - e^{-2q}) + (X_{k-1} - \mu)e^{-q}\right)$$

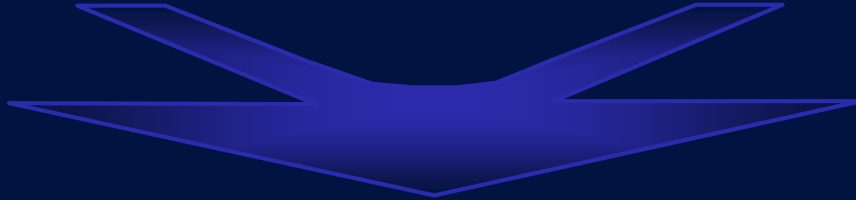
...IN ORDER TO IMPLEMENT MODELS WITH PREDICTIVE CAPABILITIES WHICH ALLOW THE IDENTIFICATION OF ABNORMAL MOVEMENTS IN THE VARIABLE EXAMINED (SO-CALLED ALERTS)



FINANCIAL
VARIABLE



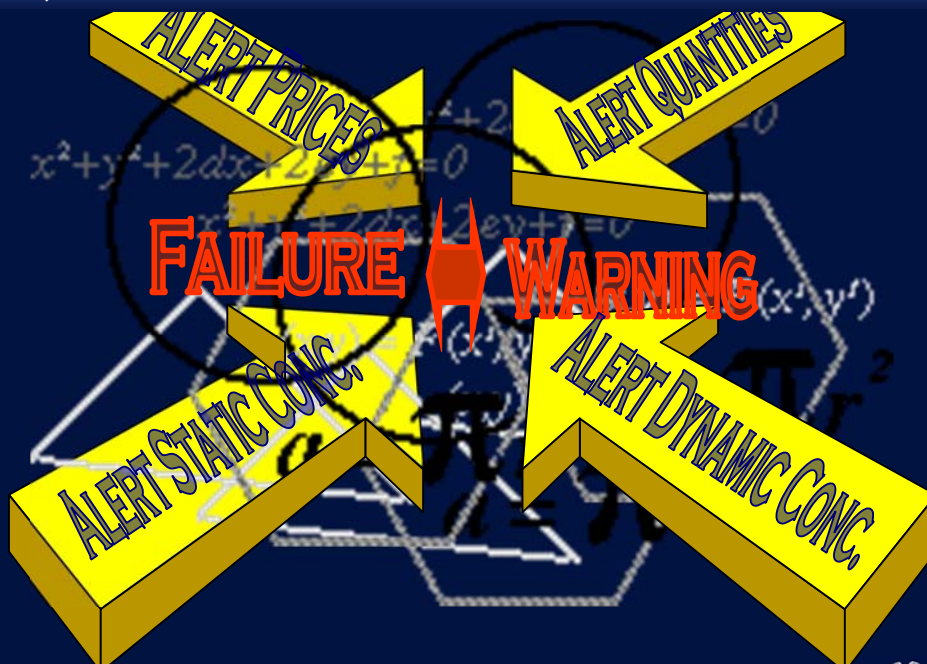
REFERENCE
MODEL



ALERT

THE STOCKS IN FAILURE AND THE SUPERVISORY WARNING GENERATION

THE JOINT READING OF THE RESULTS OF THE VARIOUS ALERTS IDENTIFIES THE STOCKS FOR WHICH THERE IS A FAILURE, WHICH BECOMES THE WARNING FOR THE CONSOB



SYLLABUS

- PRELIMINARIES ON MARKET ABUSE DETECTION
- **CONSTRUCTION OF THE MARKET ABUSE DETECTION PROCEDURE**
- EMPIRICAL RESULTS

CONSTRUCTION OF THE M.A.D. PROCEDURE

- RATIONALE OF THE PROCEDURE
- MAIN PROBLEMS ENCOUNTERED
- M.A.D. PROCEDURE CALIBRATION
- ALERT CONSTRUCTION AND WARNING GENERATION
- ANALYSIS OF THE QUANTITATIVE SOLUTION ADOPTED

THE S.A.I.V.I.M: THE PROCEDURE FOR THE MARKET ABUSE DETECTION - IMPLEMENTATION

ALERTS



WARNING



**SUPERVISORY
ACTIVITY**

CONSTRUCTION OF THE TRIPWIRES IN ORDER TO DETECT ABNORMAL MOVEMENTS OF THE FINANCIAL VARIABLES: SO-CALLED **ALERT**

DEFINITION OF THE ALGORITHM THAT - BY READING THE ALERTS - IDENTIFIES ON A DAILY BASIS THE STOCKS WHICH ENTAILS SOME FAILURES, SO-CALLED **WARNING**

COMPREHENSION OF THE REASONS UNDERLYING THE **WARNING** AND CONSEQUENT DECISIONS

CONSTRUCTION OF THE S.A.I.V.I.M: **MAIN PROBLEMS**

- ✦ THE STOCKS LISTED ON THE MARKET ARE DIFFERENT AS REGARDS:
 - LIQUIDITY
 - SECTOR TO WHICH THEY BELONG
 - P/E
 -
- ✦ THE MARKET IS CHARACTERISED BY MOMENTS OF BOOST/ “EUPHORY” OR OF “CRISIS” WHICH MAY BE GENERALIZED OR BOUNDED TO SOME SECTORS (FOR EXAMPLE , THE 2000 BUBBLE ON TECHNOLOGY STOCKS)
- ✦ THE TIME HORIZON FOR THE FAILURES ANALYSIS CANNOT BE TOO LONG (FOR INSTANCE: A QUARTER, A SEMESTER , A YEAR) IN ORDER TO AVOID THE RISK OF LOSING SENSITIVITY:
 - CHANGES IN THE STRATEGIC AREA OF BUSINESS OF THE COMPANY;
 - NEW LISTINGS
 - ...
- ✦ THE CONSTRUCTION OF THE TRIPWIRES AND OF THE ALGORITHM WHICH PRODUCES THE WARNING NEEDS TO BE VALID OVER ALL THE STOCKS AND TO PRESERVE THE ADEQUACY OF ITS PERFORMANCE OVER TIME

MAIN PROBLEMS

MAY BE SOLVED

...THROUGH AN ADEQUATE AND
ROBUST **CALIBRATION** OF THE
M.A.D. PROCEDURE

S.A.I.Vi.M.: THE CALIBRATION OF THE PROCEDURE

THE REFERENCE
SAMPLE



AIM: TO EXPLAIN THE FAILURES
OBSERVED IN THE REFERENCE
SAMPLE

(PROBLEM OF STOCHASTIC PROGRAMMING)

ALERTS



WARNING

CHOICE OF THE DISCRETE PROCESS,
DERIVATION OF THE RELATIVE DIFFUSIVE
PROCESS AND ESTIMATION OF THE
PARAMETERS FOR EACH FINANCIAL
VARIABLE

CHOICE OF THE ALGORITHM FOR THE
IDENTIFICATION OF THE FAILURE ON THE
STOCK, I.E. THE CONSOB WARNING

S.A.I.Vi.M.:

THE CALIBRATION OF THE PROCEDURE

THE REFERENCE SAMPLE

THE SET OF STOCKS AND OF THE RELATIVE OBSERVATION PERIODS HAS BEEN SELECTED BY LOOKING AT THOSE CASES FOR WHICH BOTH THE FAILURES AND THEIR REASONS WERE KNOWN

THE **STOCKS SELECTION** (N.40) WAS ORIENTED BY:

- ✦ THE PRESENCE OF AN INVESTIGATION CARRIED ON BY CONSOB;
- ✦ THE EXISTENCE OF A CONSOB SIGNALLING TO THE JUDICIAL AUTHORITY REGARDING AN HYPOTHESIS OF MARKET ABUSE;
- ✦ THE LIQUIDITY OF THE STOCK;
- ✦ THE HISTORICAL VOLATILITY OF THE STOCK;
- ✦ THE *PRICE/EARNING RATIO* OF THE STOCK;
- ✦ THE DIFFUSION/SPREADING OF THE STOCK ON THE MARKET.

S.A.I.Vi.M.:

THE CALIBRATION OF THE PROCEDURE

THE REFERENCE SAMPLE

THE SET OF STOCKS AND OF THE RELATIVE OBSERVATION PERIODS HAS BEEN SELECTED BY LOOKING AT THOSE CASES FOR WHICH BOTH THE FAILURES AND THEIR REASONS WERE KNOWN

THE **SELECTION OF THE TIME HORIZONS** (AVERAGE=20 MONTHS) WAS ORIENTED BY:

- ✦ THE PERIOD OF THE INVESTIGATION
- ✦ THE MOMENT IN WHICH THE STOCK WAS LISTED
- ✦ THE OPERATIONS OF M&A
- ✦ THE MOMENT OF THE STOCK *DE-LISTING*

S.A.I.Vi.M: THE CHOICE OF THE MODELS

- ◆ **DEVELOPING THE MODELS FOR THE TRIPWIRES THROUGH THE EMPLOYMENT OF DIFFUSIVE PROCESSES:**
THAT'S BECAUSE DIFFUSIVE PROCESSES EXPLOITING SOME RESULTS OF THE STOCHASTIC LIMIT THEORY PROVE TO BE:
 - ◆ EXTREMELY SUITABLE/PROPER FOR THE REPRESENTATION OF THE PHENOMENA
 - ◆ GOOD-PERFORMING EVEN WHEN THE NUMBER OF THE OBSERVATIONS IS LOW
 - ◆ ABLE TO SIMPLIFY THE PROBLEMS CONCERNING THE ESTIMATION AND THE STABILITY OF THE PARAMETERS
 - ◆ EASY TO IMPLEMENT

S.A.I.Vi.M. AND THE EMPIRICAL EVIDENCE: MAIN RESULTS

- ◆ **ALL THE TRADING PERIODS HIGHLIGHTED AS CRITICAL IN THE REPORTS FOR THE COMMISSION, SINCE RELATED TO MARKET ABUSE PHENOMENA, HAVE BEEN DETECTED**
- ◆ **MOREOVER HAVE BEEN HIGHLIGHTED OTHER PERIODS CHARACTERISED BY ONE OF THE FOLLOWING SITUATIONS:**
 - THE PRESENCE OF *RUMORS* ON THE MARKET, THAT IS OF NEWS HAVING THE POTENTIAL TO BE *PRICE SENSITIVE*,
 - THE EXISTENCE OF CONSIDERABLE CHANGES IN THE MOVEMENTS OF THE FINANCIAL VARIABLES ANALYSED.

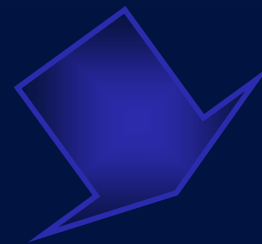
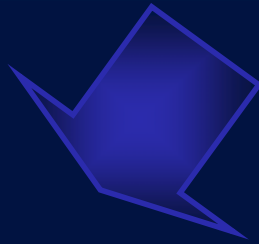
EMPIRICAL EVIDENCE: SOME FIGURES

N° OF DAYS EXAMINED	N° OF WARNINGS
10.193	267

EMPIRICAL EVIDENCE: SOME FIGURES

INFORMATIONAL REFERENCE OF THE WARNING	%
REPORT TO THE COMMISSION	22%
CONSOB NEWS	11%
BALANCE SHEET	10%
INFORMATION ON THE NET	53%
DATA ANALYSIS	4%

CONSTRUCTION OF THE ALERTS



- STATIC CONCENTRATION
- DYNAMIC CONCENTRATION

- RETURNS
- VOLUMES

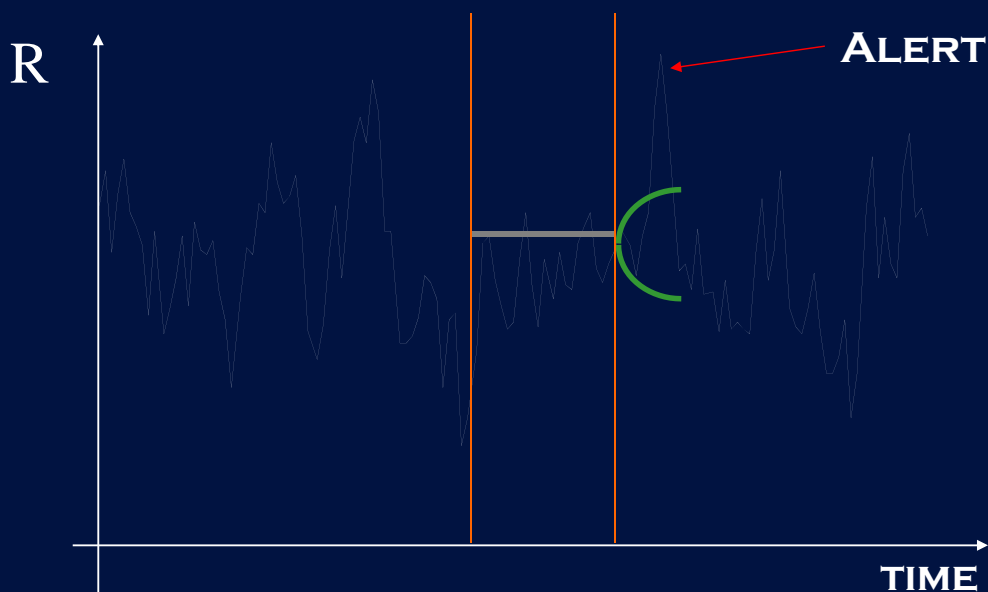


CONSTRUCTION OF THE
INDICATOR

THE CONSTRUCTION OF THE ALERTS

THE ALERT ACTIVATION

EXAMPLE: THE PRICE/RETURN ALERT



CONSTRUCTION OF THE ALGORITHM FOR THE GENERATION OF THE WARNING



THE S.A.I.V.I.M: FUNCTIONING



**THE SOFTWARE IMPLEMENTATION OF THIS
PROCEDURE OF MARKET ABUSE DETECTION
REPRESENTS:**



CONSOB

COMMISSIONE NAZIONALE
PER LE SOCIETA' E LA BORSA

**AUTOMATIC INTEGRATED
SYSTEM FOR MARKET
SURVEILLANCE**

(S.A.I.Vi.M.)

THE CONSTRUCTION OF THE ALERTS

THE PRICE ALERT

7 LOGICAL AND COMPUTATIONAL STEPS



**EMPLOYMENT OF AN
AUTO-REGRESSIVE SCHEME**

THE LOGARITHMIC TRANSFORMATION

$$R_t = \log P_t$$

1) I. THE PROCESS IN DISCRETE TIME: AR(1)

$$R_k = \alpha + \lambda R_{k-1} + \hat{\sigma} Z_k$$

$$Z_k \sim N(0,1)$$

$$R_k = \text{Log}(P_k)$$

P_k is the stock price observed at time k

1) II. THE AR(1) PROCESS IN DIFFERENTIAL TERMS

by defining $\lambda=1-\gamma$ e $\alpha = \gamma \cdot \eta$

$$R_k - R_{k-1} = \gamma(\eta - R_{k-1}) + \hat{\sigma}Z_k$$

1) III. THE STOCHASTIC INTERPRETATION

$(\Omega, \mathfrak{F}, P)$

$\{R_k\}_{k \geq 0}$ a discrete Markov process with respect to the filtration $\{\mathfrak{F}_k\}_{k \geq 0}$

where $R : \Omega \rightarrow \mathbb{R}^1$.



1. the initial distribution $\nu_0(\cdot)$
2. the transition probability $\Pi_{1,k}(\cdot, \cdot)$

both defined on $(\mathbb{R}^1, B(\mathbb{R}^1))$

1) III. THE STOCHASTIC INTERPRETATION

Let:

$$b_h(x, t) = \frac{1}{h} \int_{B(\mathbb{R}^1)} (y - x) \Pi_{h, [\frac{t}{h}]_h}(x, dy)$$

the first conditional moment

$$a_h(x, t) = \frac{1}{h} \int_{B(\mathbb{R}^2)} (y - x)(y - x)' \Pi_{h, [\frac{t}{h}]_h}(x, dy)$$

the second conditional moment

$$c_{h,i,\delta}(x, t) = \frac{1}{h} \int_{B(\mathbb{R}^n)} |(y - x)_i|^{2+\delta} \Pi_{h, [\frac{t}{h}]_h}(x, dy)$$

any moment of superior order $\forall \delta > 0, \forall i = 1, 2, \dots, n$

2) I. THE 1ST RE-SCALING OF THE PROCESS:

THE k INTERVALS ARE DIVIDED INTO $1/h$ SUBINTERVALS WITH A LENGTH h

$$R_{kh} - R_{(k-1)h} = \gamma_h (\eta_h - R_{(k-1)h}) + \sigma \sqrt{h} Z_k$$

OR

$$R_{kh} - R_{(k-1)h} = \gamma_h (\eta_h - R_{(k-1)h}) + \sigma Z_{kh}$$

$$Z_{kh} \sim N(0, \sqrt{h})$$

2) II. THE STOCHASTIC INTERPRETATION

The re-scale of the discrete time process $\{R_k\}_{k \geq 0}$



a new discrete time Markov process $\{R_{kh}\}_{kh \geq 0}$

with respect to the filtration $\{\mathfrak{F}_{kh}\}_{k \geq 0}$



1. the initial probability $\nu_0(\cdot)$,
2. the transition probability $\Pi_{h, kh}(\cdot, \cdot)$

both defined on $(\mathbb{R}^1, B(\mathbb{R}^1))$

3) I. THE 2ND RE-SCALING OF THE PROCESS:

IT IS DEFINED THE PROCESS IN THE SKOROHOD SPACE

$$R_t^h - R_{t-1}^h = \gamma_h (\mu - R_{t-1}^h) + \sigma Z_t^h$$

3) II. THE STOCHASTIC INTERPRETATION

The re-scale of $\{R_{kh}\}_{kh \geq 0}$



a continuous time process $\{R_t^h\}$

defined on D , where:

$$D([0, \infty), \mathbb{R}^1) \stackrel{def}{=} \left\{ f : [0; \infty) \rightarrow \mathbb{R}^1 : \forall t, \begin{matrix} f(t^+) = f(t) \\ f(t^-) = \text{exists} \end{matrix} \right\}$$

$kh \leq t < (k+1)h$

NELSON, ARCH MODELS AS DIFFUSION APPROXIMATIONS
JOURNAL OF ECONOMETRICS, 45, 7-38 (1990)



$\{R_t^h\}$ is a jump chain defined by:

1. the jump time that happens at times $J_{kh} = kh \quad \forall k \geq 0$,
2. the holding time that has width $(k+1)h - kh$ for $k \geq 0$ where :

$$\{R_t^h\} = \{R_{kh}\} \text{ per } kh \leq t < (k+1)h$$

4) I. THE WEAK CONVERGENCE FOR $h \downarrow 0$

$$R_t^h - R_{t-1}^h = \gamma_h (\mu - R_{t-1}^h) + \sigma Z_t^h$$

IN OTHER WORDS...

WE ARE GOING TO FIND A PROBABILISTIC RELATIONSHIP THAT WILL ALLOW TO INFER *A-PRIORI* SOME INFORMATION ON THE PROBABILITY DENSITY FUNCTION OF THE STOCHASTIC PROCESS

4) II. THE WEAK CONVERGENCE FOR $h \downarrow 0$



THE CONVERGENCY THEOREM

STROOCK, D.W. E VARADHAN S.R.S. (1979)
 MULTIDIMENSIONAL DIFFUSION PROCESSES.
 SPRINGER VERLAG, BERLIN.

THE CONVERGENCY THEOREM

the sequence $\{R_t^h\}$ weakly converges for $h \downarrow 0$ to the process $\{R_t\}$ which has a unique distribution and is characterised by the following stochastic differential equation:

$$dR_t = b(x, t)dt + \sigma(x, t)dW_t$$

if :

1. $\lim_{h \downarrow 0} c_{h, \delta}(x, t) = 0$
2. $\lim_{h \downarrow 0} b_h(x, t) = b(x, t)$
3. $\lim_{h \downarrow 0} a_h(x, t) = a(x, t)$
4. $\sigma(x, t) = \sqrt{a(x, t)}$

4) II. THE WEAK CONVERGENCE FOR $h \downarrow 0$

$$R_t^h - R_{t-1}^h = \gamma_h (\mu - R_{t-1}^h) + \sigma Z_t^h$$

THE CONVERGENCY THEOREM

$$\left\{ \begin{array}{l} \lim_{h \downarrow 0} \frac{\gamma_h^3}{h} (\mu - X_t^h)^3 + 3\sigma^2 \gamma_h (\mu - X_t^h) \stackrel{?}{=} 0 \\ \lim_{h \downarrow 0} \frac{\gamma_h}{h} (\mu - X_t^h) \stackrel{?}{=} b(x, t) \\ \lim_{h \downarrow 0} \frac{\gamma_h^2}{h} (\mu - X_t^h)^2 + \sigma^2 \stackrel{?}{=} a(x, t) \end{array} \right.$$

4) III. THE WEAK CONVERGENCE FOR $h \downarrow 0$

$$R_k - R_{k-1} = \gamma (\eta - R_{k-1}) + \hat{\sigma} Z_k$$

LIM $h \downarrow 0$

$$dR_t = q(\mu - X_t)dt + \sigma dW_t$$

5) THE SDE PROPERTIES

(ORNSTEIN-UHLENBECK ARITHMETIC PROCESS)

$$R_t \sim N \left((R_{t-1} - \mu)e^{-q} + \mu; \sqrt{\frac{\sigma^2}{2q}(1 - e^{-2q})} \right)$$

6) I. THE DISCRETE VS CONTINUOUS TIME RELATIONSHIP AND THE PARAMETERS ESTIMATION

THE PROCESS AR(1) SPECIFICATION ALLOWS TO AVOID NUMERICAL PROCEDURES

$$R_k - R_{k-1} = \gamma(\eta - R_{k-1}) + \hat{\sigma}Z_k$$

EMPLOYMENT
OF THE SDE
PROPERTIES

DIXIT – PINDYCK (1989)
INVESTMENT UNDER UNCERTAINTY
WILEY, LONDON

$$dR_t = q(\mu - R_t)dt + \sigma dW_t$$

6) III. THE DISCRETE VS CONTINUOUS TIME
RELATIONSHIP AND THE PARAMETERS
ESTIMATION

$$R_k - R_{k-1} = (1 - e^{-q}) \cdot \mu + (e^{-q} - 1) \cdot R_{k-1} + \sqrt{\frac{\sigma^2}{2q}} (1 - e^{-2q}) Z_k$$



$$R_k - R_{k-1} = \hat{a} + \hat{b}R_{k-1} + \varepsilon_k$$

6) IV. THE DISCRETE VS CONTINUOUS TIME
RELATIONSHIP AND THE PARAMETERS
ESTIMATION

$$\mu = -\frac{\hat{a}}{\hat{b}}$$

$$q = \log(\hat{b} + 1)^{-1}$$

$$\sigma = \sqrt{\sum_k \frac{\varepsilon_k^2}{n-2}} \cdot \sqrt{\frac{\log(\hat{b} + 1)^2}{\hat{b}^2 + 2\hat{b}}}$$

$k = 15$ INFRA-MONTHLY ANALYSIS

7) THE DETECTION OF THE ABNORMAL PATTERN FOR THE F.V.

LA NORMALITY PREDICTION INTERVAL

$$P \left(\begin{array}{c} \mu - z_{\frac{\alpha}{2}} \sqrt{\frac{\sigma^2}{2q} (1 - e^{-2q})} + (R_t - \mu) e^{-q} \leq \\ \leq R_{t+1} \leq \\ \leq \mu + z_{\frac{\alpha}{2}} \sqrt{\frac{\sigma^2}{2q} (1 - e^{-2q})} + (R_t - \mu) e^{-q} \end{array} \right) = \alpha$$

THE VOLUME ALERT

7 LOGICAL AND COMPUTATIONAL STEPS



RAW DATA EXAMINED ACCORDING TO AN AUTOCORRELATION SCHEME

THE RAW DATA

$$Q_t = \sum_i A(i) + V(i)$$

A = purchases

V = sales

j denotes the intermediary

THE MODELS IN DISCRETE AND IN CONTINUOUS TIME

$$Q_k - Q_{k-1} = -\gamma Q_{k-1} + \hat{\sigma} Z_k$$



$$dQ_t = -\theta Q_t dt + \sigma dW_t$$

THE SPECIFIED DISCRETE PROCESS AND THE PARAMETERS ESTIMATION

$$Q_k - Q_{k-1} = (e^{-\theta} - 1) \cdot Q_{k-1} + \sqrt{\frac{\sigma^2}{2\theta}} (1 - e^{-2\theta}) Z_k$$

$$\theta = \log(\hat{b} + 1)^{-1}$$

$$\sigma = \sqrt{\sum_k \frac{\varepsilon_k^2}{n-1}} \cdot \sqrt{\frac{\log(\hat{b} + 1)^2}{\hat{b}^2 + 2\hat{b}}}$$

$k = 15$  INFRA-MONTHLY ANALYSIS

THE NORMALITY PREDICTION INTERVAL

$$P \left(\begin{array}{l} z_{\frac{\alpha}{2}} \sqrt{\frac{\sigma^2}{2\theta}} (1 - e^{-2\theta}) + Q_t e^{-\theta} \leq \\ \leq Q_{t+1} \leq \\ \leq \mu + z_{\frac{\alpha}{2}} \sqrt{\frac{\sigma^2}{2\theta}} (1 - e^{-2\theta}) + Q_t e^{-\theta} \end{array} \right) = \alpha$$

THE ALERTS ON THE CONCENTRATION



DEFINITION OF A SYNTHETIC INDICATOR



DATA EXAMINED ACCORDING TO A AUTOCORRELATION SCHEME

MINENNA, DETECTING MARKET ABUSE, RISK, 10/2004

MINENNA, THE DETECTION OF MARKET ABUSE ON FINANCIAL MARKETS: A QUANTITATIVE APPROACH,
QUADERNI DI FINANZA CONSOB N. 54

MARCELLO MINENNA

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STATIC CONCENTRATION

ENTROPY INDEX

$$\Theta_t = \frac{1}{n_t} \sum_{i=1}^{n_t} \left(\frac{\hat{Q}_t(i)}{\mu_t} \right)^\alpha$$

WHERE

$$\hat{Q}_t(i) = \sum_{i=1}^{n_t} Q_{t-5}(i) \quad \mu_t = \frac{\sum_{i=1}^{n_t} \hat{Q}_t(i)}{n_t}$$

n_t IS THE NUMBER OF INTERMEDIARIES PRESENT ON THE MARKET AT TIME t

$Q_t(i)$, $i = 1, \dots, n_t$ ARE THE QUANTITIES TRADED BY THE i^{th} INTERMEDIARY AT TIME t

MARCELLO MINENNA

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STATIC CONCENTRATION

CONSIDERATION/REMARK:

- THE NEED TO CAPTURE NOT ONLY THE MOVEMENT IN THE VARIABLE FOR THE TOTAL TURNOVER OF THE MARKET BUT ALSO THE POSSIBLE DIRECTIONS TAKEN BY INDIVIDUAL INTERMEDIARIES AND, HENCE THE MARKET, REQUIRES THE DEFINITION OF 3 DIFFERENTS **PRE-ALERTS**

STATIC CONCENTRATION

THE PRE-ALERTS



**QUANTITIES
BOUGHT**

$$Q_t^A = \sum_i A(i)$$

GROSS TURNOVER

$$Q_t = \sum_i A(i) + V(i)$$

**QUANTITIES
SOLD**

$$Q_t^V = \sum_i V(i)$$

STATIC CONCENTRATION

SEE

-MINENNA, DETECTING MARKET ABUSE, RISK, 10/2004

-MINENNA, THE DETECTION OF MARKET ABUSE ON FINANCIAL MARKETS: A QUANTITATIVE APPROACH, QUADERNI DI FINANZA CONSOB N. 54

FOR THE COMPLETE DESCRIPTION OF THE MATHEMATICS ON:

- THE MODELS IN DISCRETE AND IN CONTINUOUS TIME
- THE SPECIFIED DISCRETE PROCESS AND THE PARAMETERS ESTIMATION
- THE NORMALITY PREDICTION INTERVAL

STATIC CONCENTRATION

THE ALERT'S GENERATION



STATIC CONCENTRATION

CONSIDERATION/REMARK:

- THROUGH SOME EASY MATHEMATICAL STEPS/PASSAGES IT IS POSSIBLE TO IDENTIFY THE INTERMEDIARIES WHO GENERATED THE ALERT

DYNAMIC CONCENTRATION

DISSIMILARITY INDEX

$$\Psi_t = \sqrt{\frac{1}{\tilde{n}_t} \sum_{i=1}^{\tilde{n}_t} \tilde{Q}_t(i)^2}$$

WHERE

$$\tilde{Q}_t(i) = Q_t(i) - Q_{t-k}(i)$$

$$\tilde{n}_t \doteq n_t : \tilde{Q}_t(i) \neq 0$$

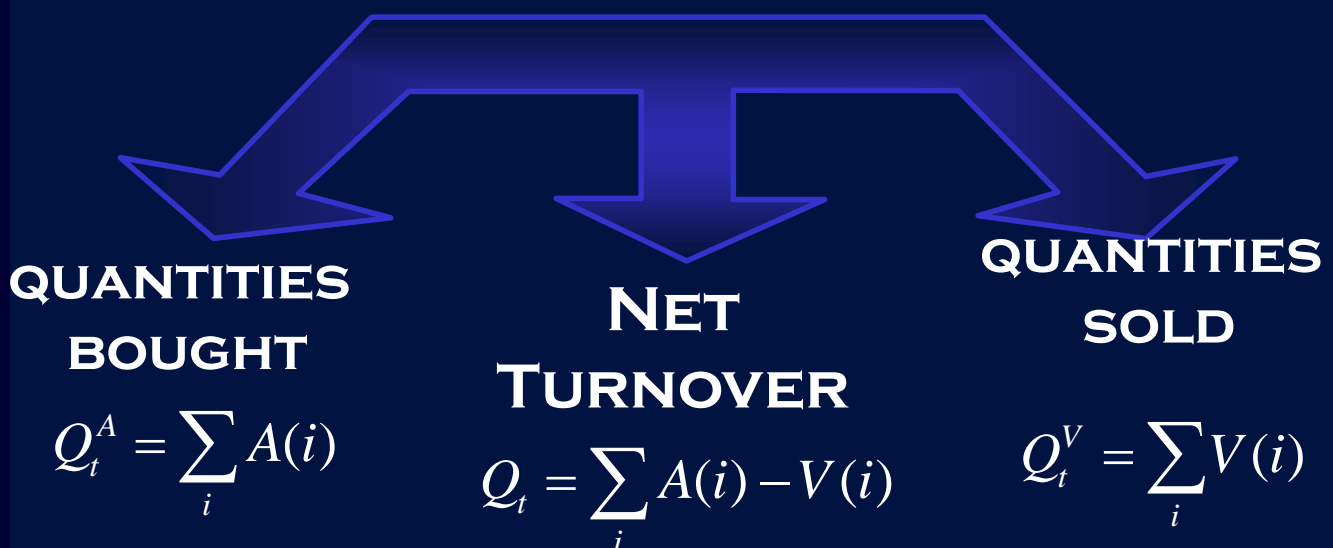
DYNAMIC CONCENTRATION

CONSIDERATION/REMARK:

- THE NEED TO CAPTURE NOT ONLY THE MOVEMENT IN THE VARIABLE FOR THE TOTAL TURNOVER OF THE MARKET BUT ALSO THE POSSIBLE DIRECTIONS TAKEN BY INDIVIDUAL INTERMEDIARIES AND, HENCE THE MARKET, REQUIRES THE DEFINITION OF 3 DIFFERENTS **PRE-ALERTS**

DYNAMIC CONCENTRATION

THE PRE-ALERTS



DYNAMIC CONCENTRATION

SEE

-MINENNA, DETECTING MARKET ABUSE, RISK, 10/2004

-MINENNA, THE DETECTION OF MARKET ABUSE ON FINANCIAL MARKETS: A QUANTITATIVE APPROACH, QUADERNI DI FINANZA CONSOB N. 54

FOR THE COMPLETE DESCRIPTION OF THE MATHEMATICS ON:

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DYNAMIC CONCENTRATION

THE ALERT'S GENERATION



DYNAMIC CONCENTRATION

CONSIDERATION/REMARK:

- THROUGH SOME EASY MATHEMATICAL STEPS/PASSAGES IT IS POSSIBLE TO IDENTIFY/SPOT THE INTERMEDIARIES WHO GENERATED THE ALERT

SYLLABUS

- PRELIMINARIES ON MARKET ABUSE DETECTION
- CONSTRUCTION OF A MARKET ABUSE DETECTION PROCEDURE
- **EMPIRICAL RESULTS**

EMPIRICAL RESULTS

- **SUMMARY OF THE KEY-FEATURES OF S.A.I.Vi.M.**
- **ANALYSIS OF THE WARNINGS GENERATION OF S.A.I.Vi.M.**
- **COMPARISON BETWEEN SAIVIM AND A STANDARD ECONOMETRIC PROCEDURE**
- **CONSOB MARKET ABUSE INVESTIGATIONS PERIOD 2000-2004**

EMPIRICAL RESULTS

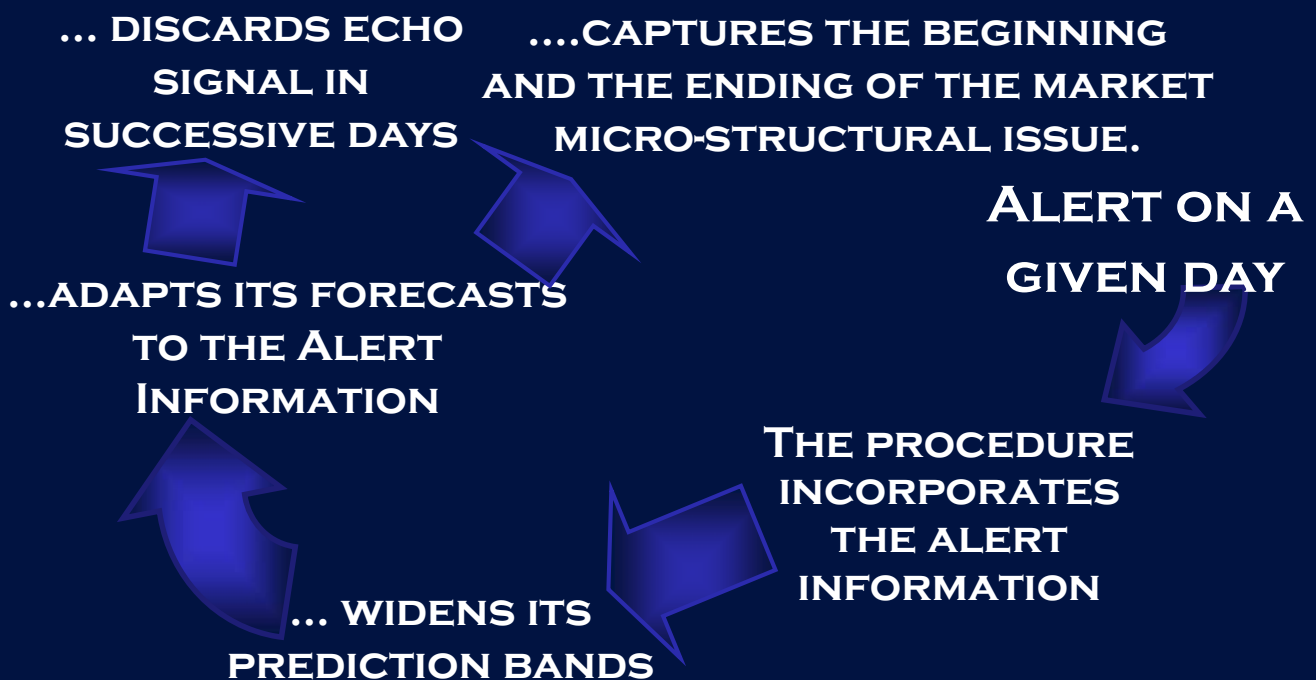
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SUMMARY OF THE KEY-FEATURES OF S.A.I.Vi.M.

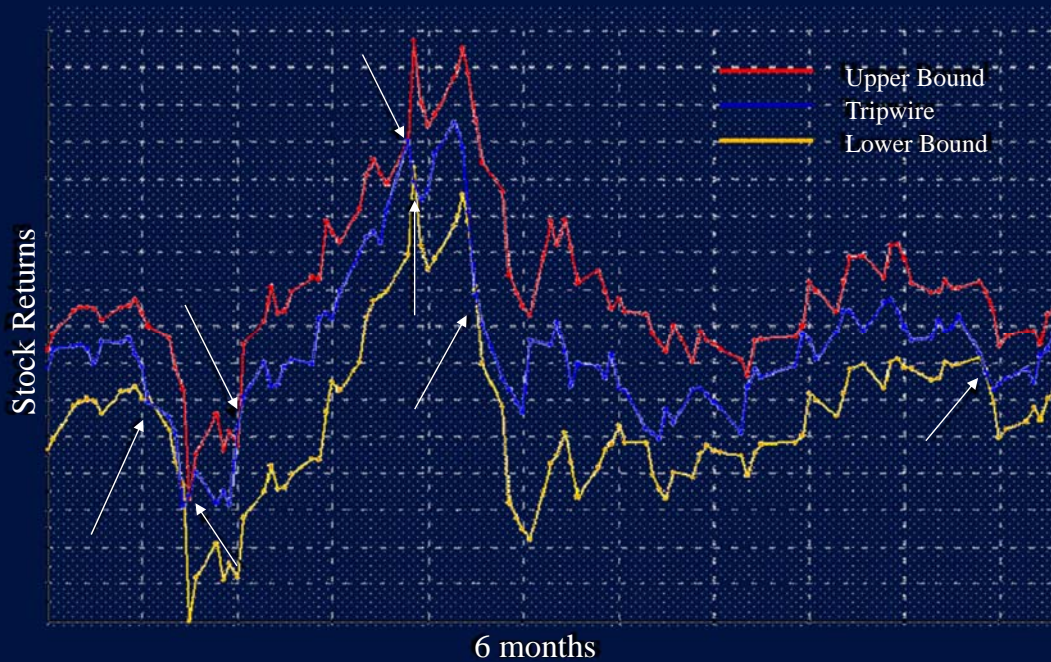
- **ADAPTIVE CAPABILITY**
- WEAK CONVERGENCY OF DISCRETE TIME PROCESSES INTO CONTINUOUS TIME TREATABLE STOCHASTIC DIFFERENTIAL EQUATIONS
- CONSISTENT BRIDGE BETWEEN THE DISCRETE AND THE CONTINUOUS TIME PROCESS PARAMETERS
- SHORT TIME – SERIES DATA SET
- ONE PARAMETER CALIBRATES THE ENTIRE PROCEDURE

EMPIRICAL RESULTS - SUMMARY OF THE KEY-FEATURES OF S.A.I.Vi.M.

ADAPTIVE CAPABILITY - INTUITION



ADAPTIVE CAPABILITY - INTUITION



EMPIRICAL RESULTS

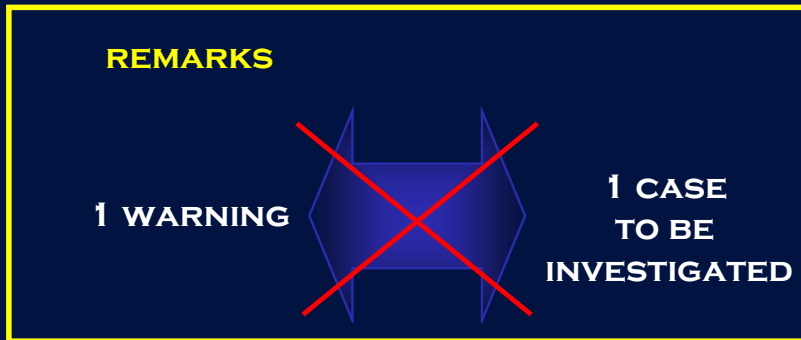
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EMPIRICAL RESULTS

ANALYSIS OF THE WARNINGS GENERATION OF S.A.I.Vi.M. WARNINGS GENERATED IN AVERAGE OVER 1 YEAR



**1.800 WARNINGS FOR 270 LISTED SECURITIES ON THE
ITALIAN STOCK EXCHANGE**



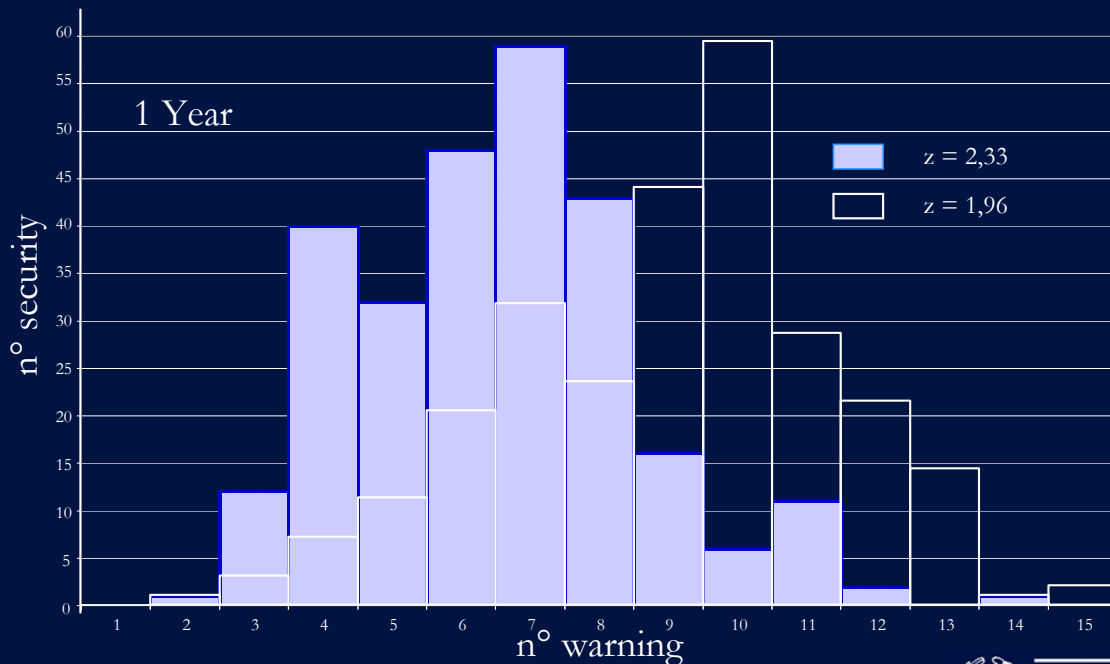
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EMPIRICAL RESULTS - ANALYSIS OF THE WARNINGS GENERATION OF S.A.I.Vi.M.

ITALIAN LISTED SECURITIES IN RELATION WITH THE WARNINGS GENERATED BY THE PROCEDURE.



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EMPIRICAL RESULTS

- SUMMARY OF THE KEY-FEATURES OF S.A.I.Vi.M.
- ANALYSIS OF THE WARNINGS GENERATION OF S.A.I.Vi.M.
- **COMPARISON BETWEEN SAIVIM AND A STANDARD ECONOMETRIC PROCEDURE**
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COMPARISON BETWEEN SAIVIM AND A STANDARD ECONOMETRIC PROCEDURE

SAMPLE OF 22 MARKET ABUSE CASES

$x^2+y^2+2dx+2ey+f=0$
PROBABILISTIC
 $(x,y) = F(x',y')$
S.A.I.Vi.M.

VS



ECONOMETRIC

DAILY ESTIMATE OF THE ABNORMAL RETURNS, CONDUCTED THROUGH THE AR(1) PROCESS, ADOPTING AN HYPOTHESIS TESTING WITH A TYPE I ERROR OF 1%,



COMPARISON BETWEEN SAIVIM AND A STANDARD ECONOMETRIC PROCEDURE

SAMPLE OF 22 MARKET ABUSE CASES

Company	Abnormal Transactions		Report to Judicial Authority: Date	Case Description	Warning Generation: Detail of the Alerts				ECONOMETRIC PROCEDURE RETURN
	Date of Beginning	Date of Ending			Return	Volume	Static Conc.	Dinamic Conc.	
Alleanza Assicurazioni	08/11/2001	12/11/2001	21/05/2002	Insider trading involving some transactions on Alleanza Assicurazioni saving shares in the period preceding the conversion of these shares into the ordinary ones	YES	YES	YES	YES	NO
Allianz	before the 06/09/00		12/10/2001	Insider trading involving some transactions on Allianz Subalpina shares in the period preceding the announcement of the decision taken by Ras SpA to launch a takeover-bid on these shares	YES	YES	YES	YES	NO
Banca Legnano	18/12/2000	19/12/2000	30/11/2001	Insider trading involving some transactions on Banca di Legnano shares in the period preceding the announcement of the disposal to Banca Popolare di Milano of the control stock held by Banca Intesa to Banca Popolare di Milano	YES	YES	YES	YES	NO
Banca Profilo	before 11/01/2000		10/01/2001	Insider trading in view of the abnormal pattern of Banca Profilo shares in the period preceding the announcement of the activation of a plan for the realization of an innovative service on network data transmission	YES	YES	YES	YES	NO
Burgo	before the 19/04/00		27/12/2000	Insider trading in view of the abnormal performance of the shares of Cartiere Burgo SpA in the period preceding the announcement of a takeover-bid launched by Dieci srl	YES	YES	YES	YES	NO
Cir	before 13/09/00		09/07/2001	Insider trading on Cir saving shares in the period preceding the date in which the issuing company disclosed the approval -by the board of directors- of a proposal of converting the saving shares and the preferred shares into the ordinary ones.		YES	YES	YES	NO
Cremonini	12/01/2001	12/01/2001	02/10/2001	Insider trading involving some transactions on Cremonini SpA shares immediately before the announcement of the discovery of the first Italian case of Bovine Spongiforme Encephalopathy (BSE)		YES	YES	YES	NO

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COMPARISON BETWEEN SAIVIM AND A STANDARD ECONOMETRIC PROCEDURE

Company	Abnormal Transactions		Report to Judicial Authority: Date	Case Description	Warning Generation: Detail of the Alerts				ECONOMETRIC PROCEDURE RETURN
	Date of Beginning	Date of Ending			Return	Volume	Static Conc.	Dinamic Conc.	
D.Mail	05/11/2001	06/11/2001	25/03/2002	Action-based manipulation in view of the abnormal pattern recorded by the price of Dmail shares in the period immediately before the disclosure of the information concerning an interest in purchasing from the main shareholders at least the 81% of the of t	YES	YES		YES	NO
Fiat	06/04/2001	06/04/2001	06/12/2002	Action-based manipulation on Fiat ordinary shares related to the fact that these shares were the underlying of a put option embedded in the financial engineering of reverse convertible bonds		YES	YES	YES	NO
Generali	04/09/2000	04/09/2000	26/09/2001	Action-based manipulation in view of some transactions executed on Assicurazioni Generali shares during the pre-opening phase and related to the fact that these shares were the underlying of put options embedded in the financial engineering of reverse con		YES	YES	YES	NO
HDP	01/02/2000	14/02/2000	10/04/2000	Action-based manipulation involving some transactions on the shares of H.D.P.	YES	YES	YES	YES	NO
Inv. Imm. Lombardi	07/03/2002	20/03/2002	08/01/2003	Insider trading involving some transactions on Investimenti Immobiliari Lombardi Spa shares (now Bipielle Investimenti Spa) in the period before the announcement of the takeover bid launched by Banca Popolare di Lodi on these shares	YES	YES		YES	NO
Italiana Ass.	before the 20/04/2001		21/12/2001	Insider trading involving some transactions on Italiana Assicurazioni shares in the period preceding the announcement of the takeover-bid launched on these shares by Reale Mutua Assicurazioni	YES	YES	YES	YES	NO
Magneti Marelli	13/03/2000	05/05/2000	25/05/2001	Insider trading involving some transactions on Toro Assicurazioni and Magneti Marelli ordinary shares in the period preceding the announcement of the takeover bid launched by Fiat Spa on these shares		YES	YES	YES	NO
Pirelli&cco.	25/09/2000	26/09/2000	01/10/2001	Insider trading involving some transactions on Pirelli SpA and on Pirelli & C. ordinary shares in the period before the announcement of the disposal of the indirect holding of Pirelli SpA in Optical Technologies USA Corp. to Corning Inc.	YES	YES		YES	NO

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RESULTS - SAMPLE OF MARKET ABUSE CASES DETECTED BY SAIViM

Company	Abnormal Transactions		Report to Judicial Authority: Date	Case Description	Warning Generation: Detail of the Alerts				ECONOMETRIC PROCEDURE
	Date of Beginning	Date of Ending			Return	Volume	Static Conc.	Dinamic Conc.	RETURN
Recodati	01/09/2000	19/09/2000	03/08/2001	Insider trading involving some transactions on Recodati saving non convertible shares in the period preceding the announcement of the conversion of the saving non convertible shares into the ordinary ones	YES	YES		YES	NO
Rotondi evolution	01/06/1999	19/07/1999	08/05/2000	Action-based manipulation on Rotondi Evolution shares in view of the abnormal trading conditions recorded by these shares.	YES	YES	YES	YES	NO
Seat P.G.	before the 10/02/2000		30/07/2002	Insider trading involving some transactions on Seat ordinary shares, Seat saving non convertible shares and on financial derivative tools connected to Seat shares in the period before the announcement of the merger between Tin.it and Seat.	YES	YES	YES	YES	NO

MARKET ABUSE PHENOMENA AND SUPERVISORY AUTHORITY

EMPIRICAL RESULTS

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**CONSOB MARKET ABUSE INVESTIGATIONS
PERIOD 2000-2004**

- **2.200 DATA REQUESTS AND INTERVIEWS**
- **500 SUBJECTS INVOLVED IN A MARKET ABUSE HYPOTHESES**
- **80 REPORTS TO THE JUDICIAL AUTHORITIES WITH A MARKET ABUSE HYPOTHESES**
- **40 REPORTS WITHOUT A MARKET ABUSE HYPOTHESES FINALISED TO THE DISMISSAL OF THE CASE INVESTIGATED**

**S.A.I.Vi.M.:
THE PROBABILISTIC PROCEDURE
FOR MARKET ABUSES
DETECTION**