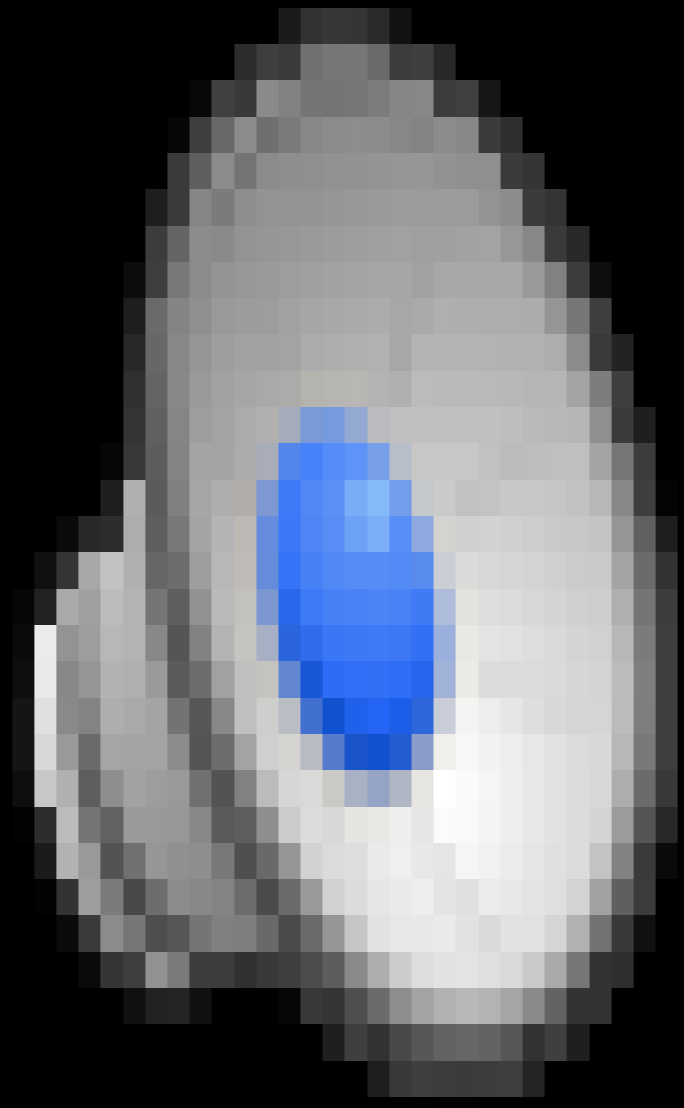


# WIDESPREAD WORRY AND THE STOCK MARKET

*Eric Gilbert, Georgia Tech*



# LAB EXPERIMENTS

## *in psych & behavioral econ*

emotions affect our choices

DOLAN, SCIENCE 2002

ZAJONC, AM. PSYCHOLOGIST 1980

*fear* affects our investment choices

LERNER, J. P&SP 2001

LOEWENSTEIN, PSYCH. BULLETIN 2002

If we estimate broad **WORRY & FEAR**,  
does it tell us anything about the **MARKET**?

# NATURAL EXPERIMENTS

## *finance & computer science*

stock market is probably not efficient

TETLOCK, J. FINANCE 2007

HIRSHLEIFER & SHUMWAY, J. FINANCE 2003

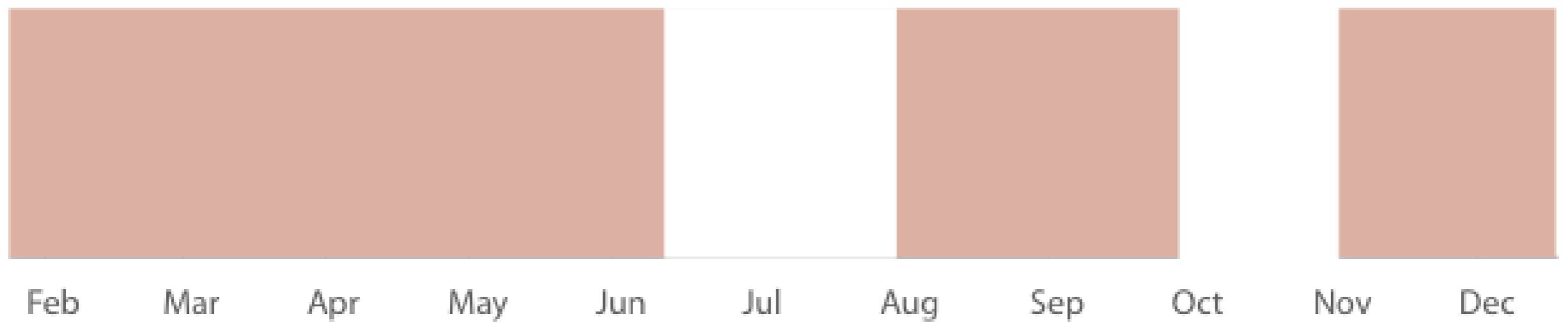
online media have predictive information

CHOI & VARIAN, GOOGLE 2009

GRUHL ET AL, KDD 2005

2008

## 2008 LiveJournal



# THE ANXIETY INDEX

*training data*

**624,905** LJ mood-annotated posts from  
2004

*extracted* **12,923** anxious, worried, nervous, fearful  
& *trained* two classifiers to discriminate



# THE ANXIETY INDEX

## *classifiers*

**C1:** boosted decision tree with top 100 stems

28% TRUE POSITIVE; 3% FALSE POSITIVE

**C2:** bagged complement naive bayes

32% TRUE POSITIVE; 6% FALSE POSITIVE (RENNIE, 2003 ICML)

## THE ANXIETY INDEX

*frequency & differencing*

$$C_t = \max(C1_t, C2_t)$$

$$A_t = \log(C_{t+1}) - \log(C_t)$$

TIME MEASURED IN TRADING DAYS

## MARKET DATA

### *returns*

Let  $SP_t$  be S&P 500 closing

price

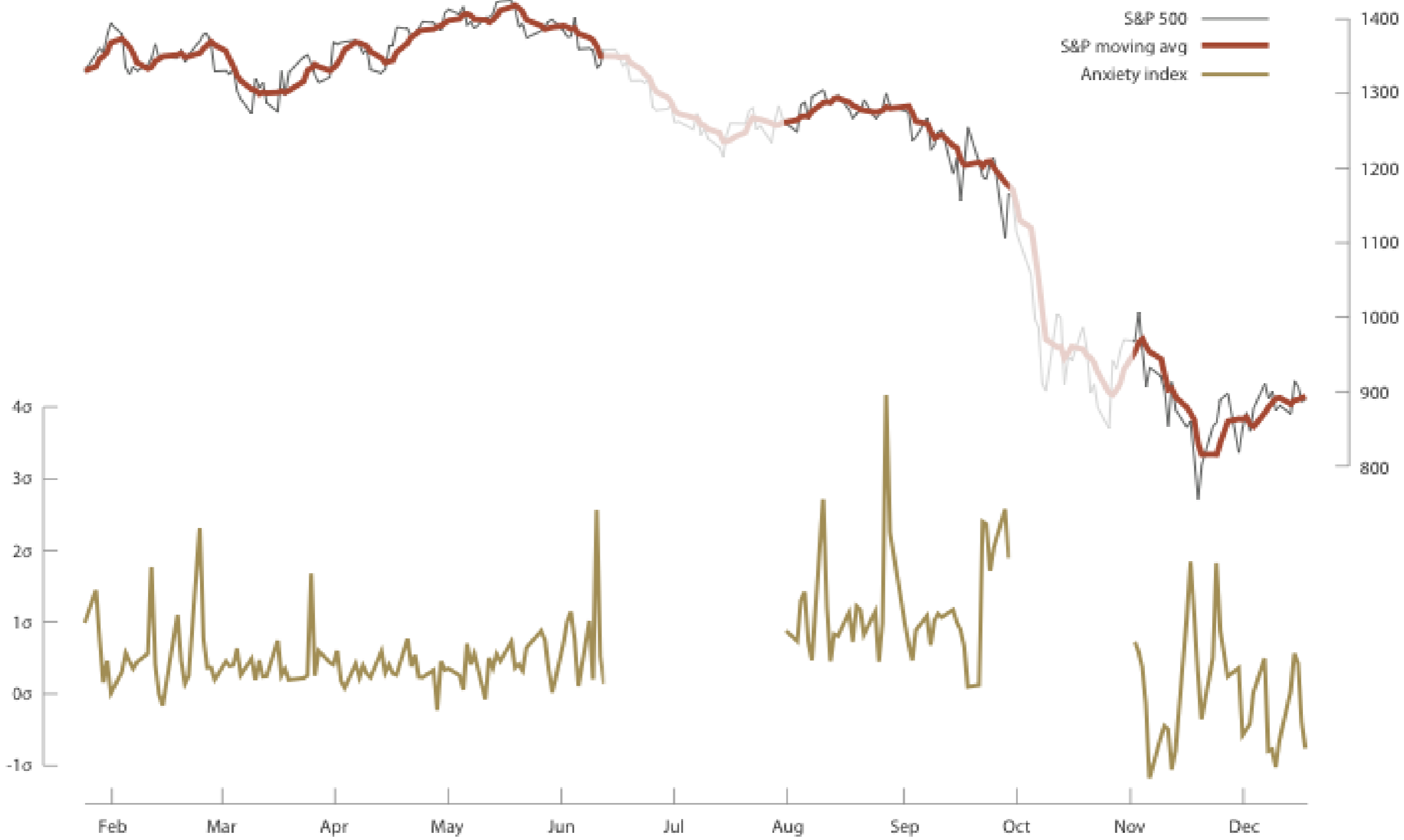
$$R_t = \log(SP_{t+1}) - \log(SP_t)$$

$$M_t = R_{t+1} - R_t$$

MARKET DATA  
*controls*

$$VLM_t = \log(VOLUME_{t+1}) - \log(VOLUME_t)$$

$$VOL_t = R_{t+1} \cdot R_{t+1} - R_t \cdot R_t$$



## METHOD

### *granger causality*

$$M_t = \alpha + \sum_{i=1}^3 \beta_i M_{t-i} + \sum_{i=1}^3 \gamma_i VOL_{t-i} \\ + \sum_{i=1}^3 \delta_i VLM_{t-i} + \epsilon_t$$

$$M_t = \alpha + \sum_{i=1}^3 \beta_i M_{t-i} + \sum_{i=1}^3 \gamma_i VOL_{t-i} \\ + \sum_{i=1}^3 \delta_i VLM_{t-i} + \sum_{i=1}^3 \lambda_i A_{t-i} + \epsilon_t$$

## METHOD

### *granger causality*

$$M_t = \alpha + \sum_{i=1}^3 \beta_i M_{t-i} + \sum_{i=1}^3 \gamma_i VOL_{t-i} \\ + \sum_{i=1}^3 \delta_i VLM_{t-i} + \epsilon_t$$

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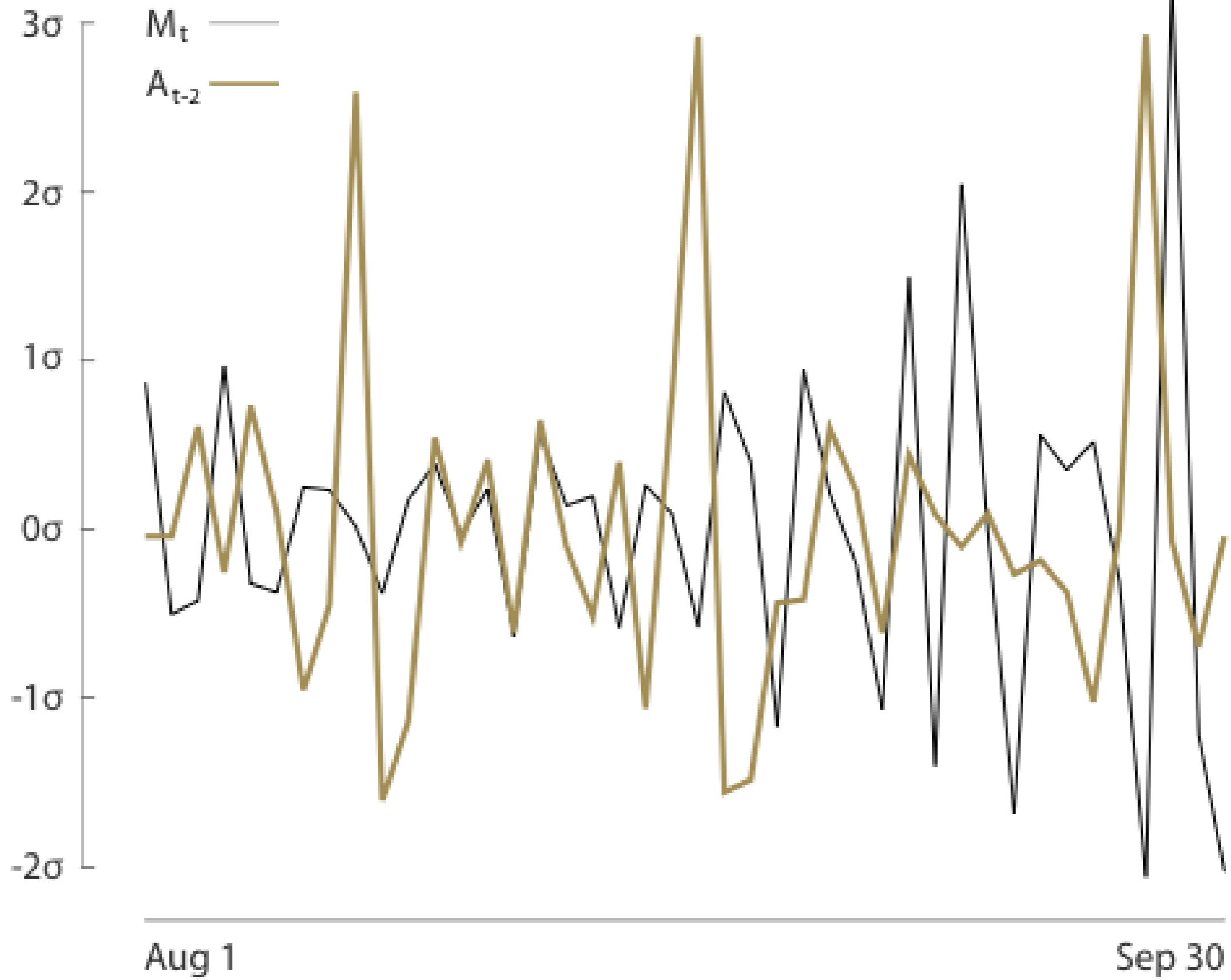
# ENDOGENOUS MODEL

$M_t$	Coeff.	Std. Err.	t	p
-1 day	-0.858	0.110	-7.83	<0.001†
-2 days	-0.655	0.095	-6.88	<0.001†
-3 days	-0.171	0.098	-1.73	0.085
$VOL_t$				
-1 day	0.149	0.076	1.96	0.051
-2 days	0.152	0.087	1.74	0.084
-3 days	0.176	0.117	1.51	0.132
$VLM_t$				
-1 day	0.054	0.080	0.68	0.497
-2 days	0.132	0.074	1.78	0.077
-3 days	0.067	0.058	1.16	0.247
<b>Summary</b>	<b>DW</b>	<b>Adj. R<sup>2</sup></b>	<b>F<sub>9,161</sub></b>	<b>p</b>
	2.054	0.509	20.58	<0.001†



## +FEAR MODEL

$M_t$	Coeff.	Std. Err.	t	p
-1 day	-0.872	0.105	-8.36	<0.001†
-2 days	-0.667	0.085	-7.81	<0.001†
-3 days	-0.182	0.087	-2.08	0.039†
$VOL_t$				
-1 day	0.182	0.063	2.90	0.004†
-2 days	0.184	0.083	2.22	0.028†
-3 days	0.177	0.109	1.63	0.105
$VLM_t$				
-1 day	0.056	0.078	0.712	0.477
-2 days	0.133	0.071	1.89	0.061
-3 days	0.071	0.059	1.20	0.232
$A_t$				
-1 day	-0.064	0.052	-1.24	0.216
-2 days	-0.128	0.060	-2.14	0.034†
-3 days	-0.136	0.084	-1.62	0.107



# MONTE CARLO SIMULATION

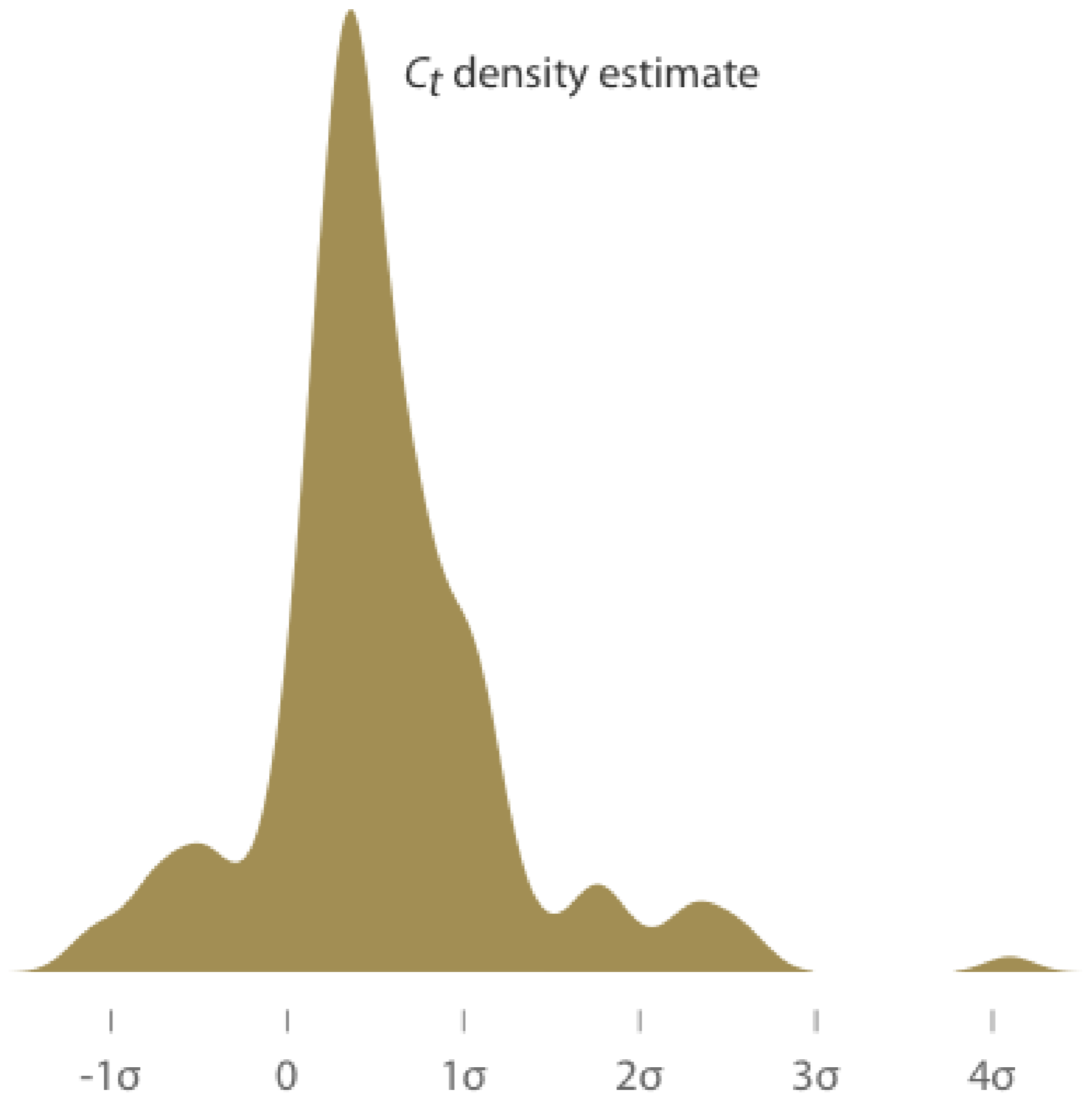
## *confirmation*

some statistical violations threaten results

NORMALITY, HETEROSCEDASTICITY  $\Rightarrow F$  DRIFT

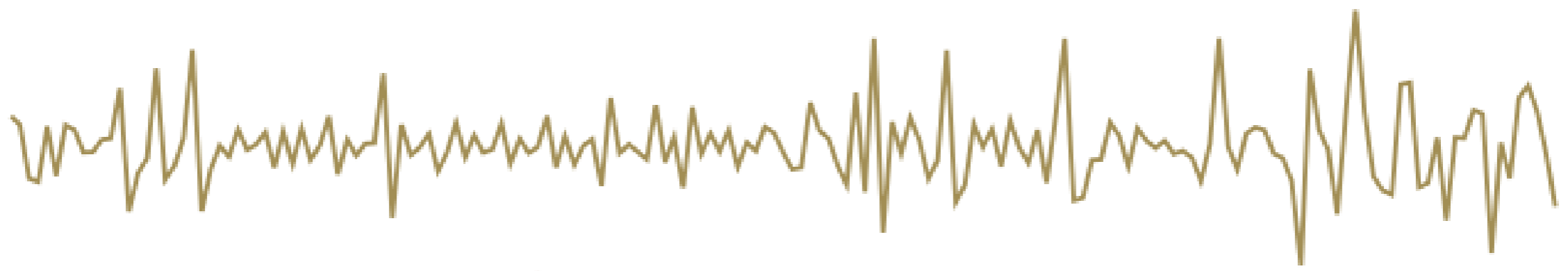
first principles approach

PERFORM MANY TESTS WITH NEW, SYNTHETIC  $A_t$



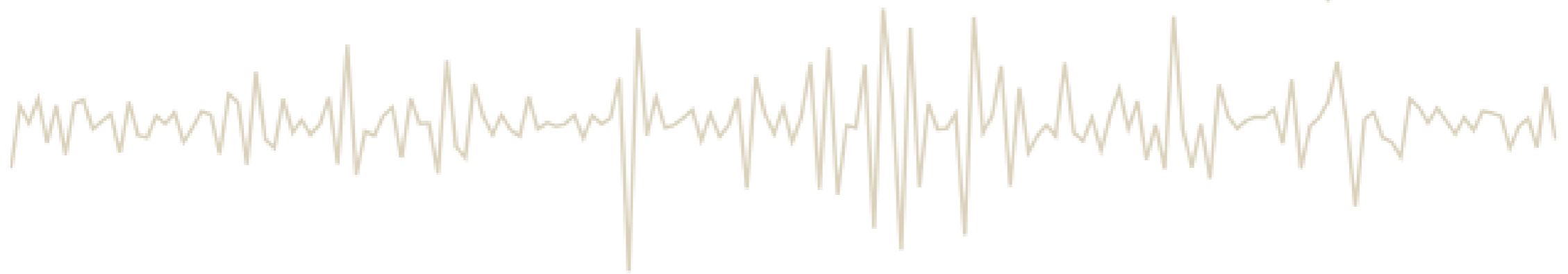
$C_t$  density estimate

$2\sigma$  —  
 $1\sigma$  —  
 $0\sigma$  —  
 $-1\sigma$  —  
 $-2\sigma$  —



—  $2\sigma$   
—  $1\sigma$   
—  $0\sigma$   
—  $-1\sigma$   
—  $-2\sigma$

$2\sigma$  —  
 $1\sigma$  —  
 $0\sigma$  —  
 $-1\sigma$  —  
 $-2\sigma$  —



Monte Carlo  $p = 0.0453$ , up from 0.0322.

Estimating worry & fear seems to contain **SOME** market direction information.